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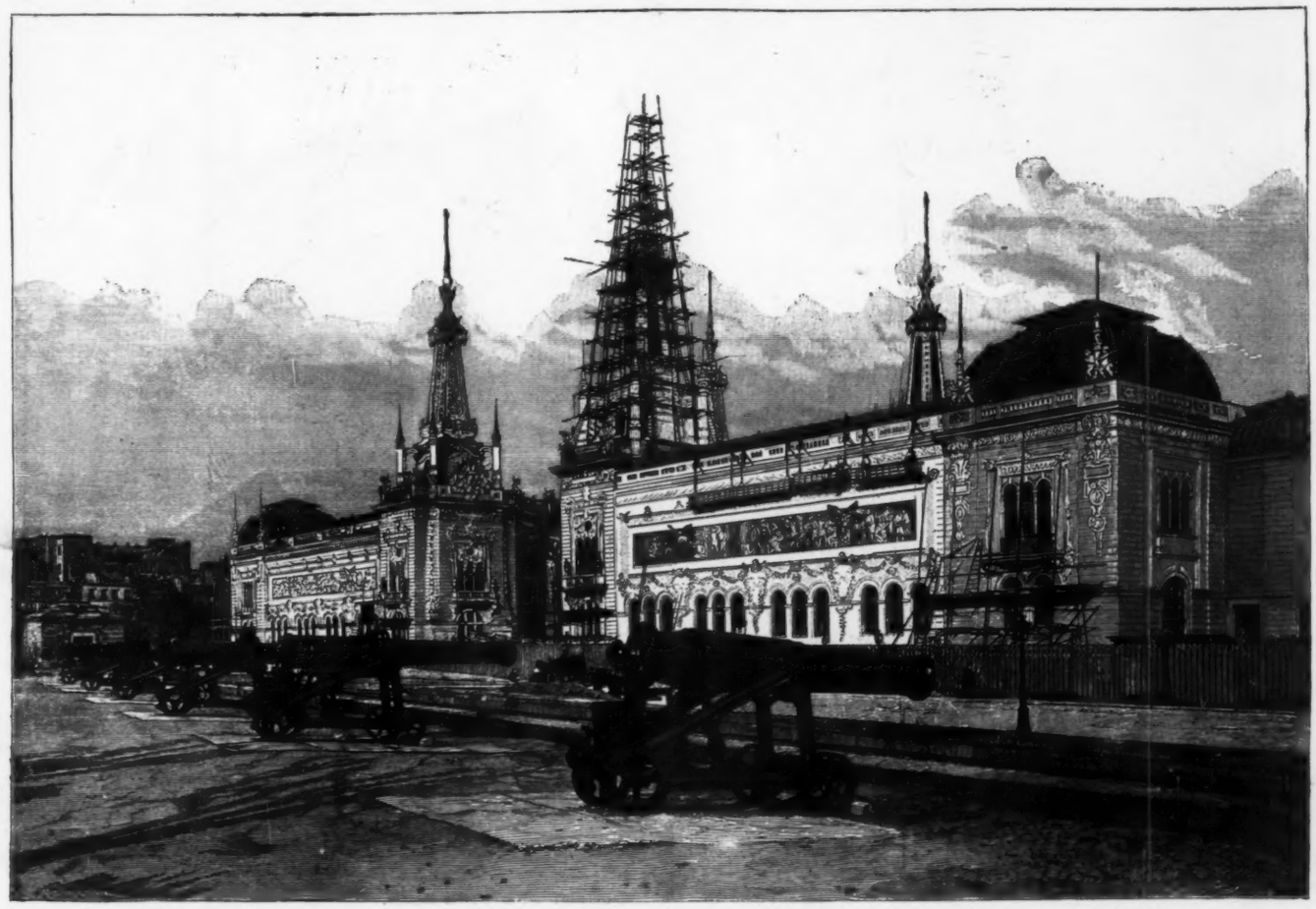
A VISIT TO THE EXPOSITION OF 1900.

WILL things be ready? This is the question that is now asked by Parisians of all classes, who assemble in crowds, principally on Sunday, at the gates of the enclosures within which work on the buildings is proceeding, upon such wharves and bridges as still remain accessible to the public, under the gallery of the rotunda of the Trocadero, and, in a word, everywhere where some of the work can be seen from the outside. And it is the same question that every one who is allowed to enter the yards tries to solve.

As a general rule those who have gone over the grounds and wandered through the structures of the Exposition from Place de la Concorde to the Machinery Palace, and from the Invalides to the Trocadero, gather from such a visit the impression and opinion that things will not be ready. They have stepped into quagmires and puddles, have slipped into holes, have sunk up to their ankles in a whitish, sticky mud, have crossed marshes upon oscillating girders and half

MOUNTING THE GREAT GERMAN DYNAMO IN THE ELECTRICITY BUILDING, CHAMP DE MARS.



THE PARIS EXPOSITION—THE PALACE OF THE ESPLANADE AS SEEN FROM THE JARDIN DES INVALIDES.

submerged planks, have retraced their steps a dozen times before heaps of plaster work and rubbish, have wandered at random among excavations and heaps of excavated material, and have made hundreds of detours in order to find a practicable means of exit, but have seen nothing but chaos; and it has appeared impossible to them that a world can rise out of chaos by the 15th of April.

DECORATIVE HEAD BRACKETS FOR THE PALACES ON THE CHAMP DE MARS.

If the weather were dry and the ground solid, the visitors to the working points of the Exposition would be more impartial, and not so pessimistic. It is not a man up to the eyes in dirt, and who has passed his time in looking on or walking around that must be asked in what state the work is. And, moreover, how is it possible to judge of its state of advancement?

Assuredly the temporary scaffoldings of wood and iron have not yet been seen to disappear; we see laborers still engaged upon the heavy work; and, even in the structures that are most advanced, innumerable gaps exist. And all this is calculated to create a feeling of anxiety. But is it not reassuring on the other hand to witness the extraordinary simultaneousness with which all the work of the most diverse kinds is pushing forward? To the summit of a column of staff, a workman is fixing molded plaster ornaments; a little lower down a painter is decorating a frieze; and at the bottom, the column is as yet but a frail metallic skeleton surrounded by a framework upon which is deposited the composition designed to simulate dressed stone. In the interior of a building, while workmen are laying the flooring at one end of a gallery, the joiners are putting in show cases at the other end, where the flooring has already been laid. Upon the freight tracks, cars are running with loads of cases containing the first shipments from foreign lands. Outside, in the center of the marsh, gardeners are laying out borders, spreading out vegetable mold, laying sod, and arranging clumps of trees. All trades are elbowing each other, and each is performing its own task without seeming to pay any attention to that of its neighbor. No feverish haste is witnessed anywhere.

If the work were behind hand, would this be so? Can we suppose any unconsciousness to exist on the part of the contractors, of the superintendents, and of those interested and responsible to various degrees? That would be unlikely, and it would seem as if such improbability ought to suffice to give confidence. All these people, who have there own business to attend to, and subordinate it as little as possible to that of others, know what they are doing. They have their assigned task and know exactly the extent thereof. The carpenter knows that he will have finished his work at such a date, the mounter at such another, and the molder at such another; and so with the joiner, decorator, roofer, etc. Who can claim that they are mistaken? How could we do more than they? And what reason have we for not reposing confidence in them?

If all the workmen have finished their task before the 14th of April, as they claim that they will have done, everything will be ready on the 15th. Let us not demand anything more than that.

The demolition of the Palace of Industry was the first work undertaken upon the site of the Exposition. The demolishers of the work of 1855 were the first laborers on that of 1900. It might be supposed that such work would be the first finished; but not at all. It was interrupted on several occasions. A single wing was first taken down, while the rest still gave shelter to a gallery of paintings and then a horse show. Then the forepart was preserved as long as possible to install therein the offices of the architects of the new palaces. After the palaces had been sufficiently closed and covered to receive the architects, plans, squares, and compasses, the demolishers resumed their work. A little of the old Palace of Industry still remained, but only a little, say as much as would be embraced in an ordinary five-story house.

Is the fact known that the work of the demolishers requires an infinite amount of carefulness? The demolisher does not destroy things right and left, but is a preserver. Everything has a value in matters of demolition. Properly scraped and touched up, this imperial crown and that semi-nude bust of a female with classic features and action, between which a policeman on duty is dreaming so melancholily, will serve for new structures. It is, perhaps, due to the fact of the utilization of such remains that architecture in our day renews itself so slowly.

At the back of the scene is outlined the Grand Palais, as yet unfinished. This, too, is a palace for the time being. It appears to be superior to the old one, but who would dare to proclaim it a chef d'œuver? Perhaps it will prove displeasing in its turn and be given over to the demolishers before a century has passed. But we no longer build except provisionally, and resemble those rich Yankees who so quickly tire of the architecture of the structure which they inhabit, and who, after living for a few years in a Swiss cottage, do not hesitate to pull it down in order to erect a Renaissance palace in its place.

REMAINS OF THE PALACES OF INDUSTRY AND FINE ARTS.

At the Exposition, everything is molding. Molders and staff workers are laboring on all sides with their oakum and fine plaster. While awaiting the invasion of exhibitors, several of the palaces have been converted into immense workshops in which are multiplying allegorical subjects, decorative heads, and symbolical bas-reliefs, all of which are designed to be placed at great heights, and are consequently of gigantic size. There are some amusing effects of repetition; incomplete trunks are aligned against a wall; farther along are seen arms and legs; and here is a whole lot of female heads with smiling countenance designed for the ornamentation of brackets. It is the property room for the accessories of the great improvised theater of the Exposition. The interior arrangement of the long palaces at right angles with the Seine, and upon the Champ de Mars will soon be completed. The painting is finished. The general color is a glaucous green, to which the eye of visitors will accommodate itself with satisfaction. It is the most hygienic of shades. In several of the sections the glass show cases are in process of being mounted. It is curious to note that it is the most fragile and delicate objects that seem to arrive first. The work of installing the laces is proceeding with activity. The Spanish section of fabrics decorates its staff exhibition space with the arms of the kingdom. It is a curious spectacle to see the wooden uprights encased in columns of plaster, molded in half cylinders, and one looks with interest upon the conversion of a stiff and ungainly framework into an elegant colonnade, which, in a few days, will be again metamorphosed by a brilliant polychromy.

Punctuality is the politeness of nations. Russia and Germany are making themselves remarked at present by the prompt shipment of their exhibits. Everywhere where cases are seen in the process of being unloaded we may be certain that we are in a Russian section; and when, on the Champ de Mars, we meet cars loaded with cylinders, pistons, connecting rods, and other large steel pieces that constitute the parts of modern mechanisms, we have only to follow them to reach the German sections.

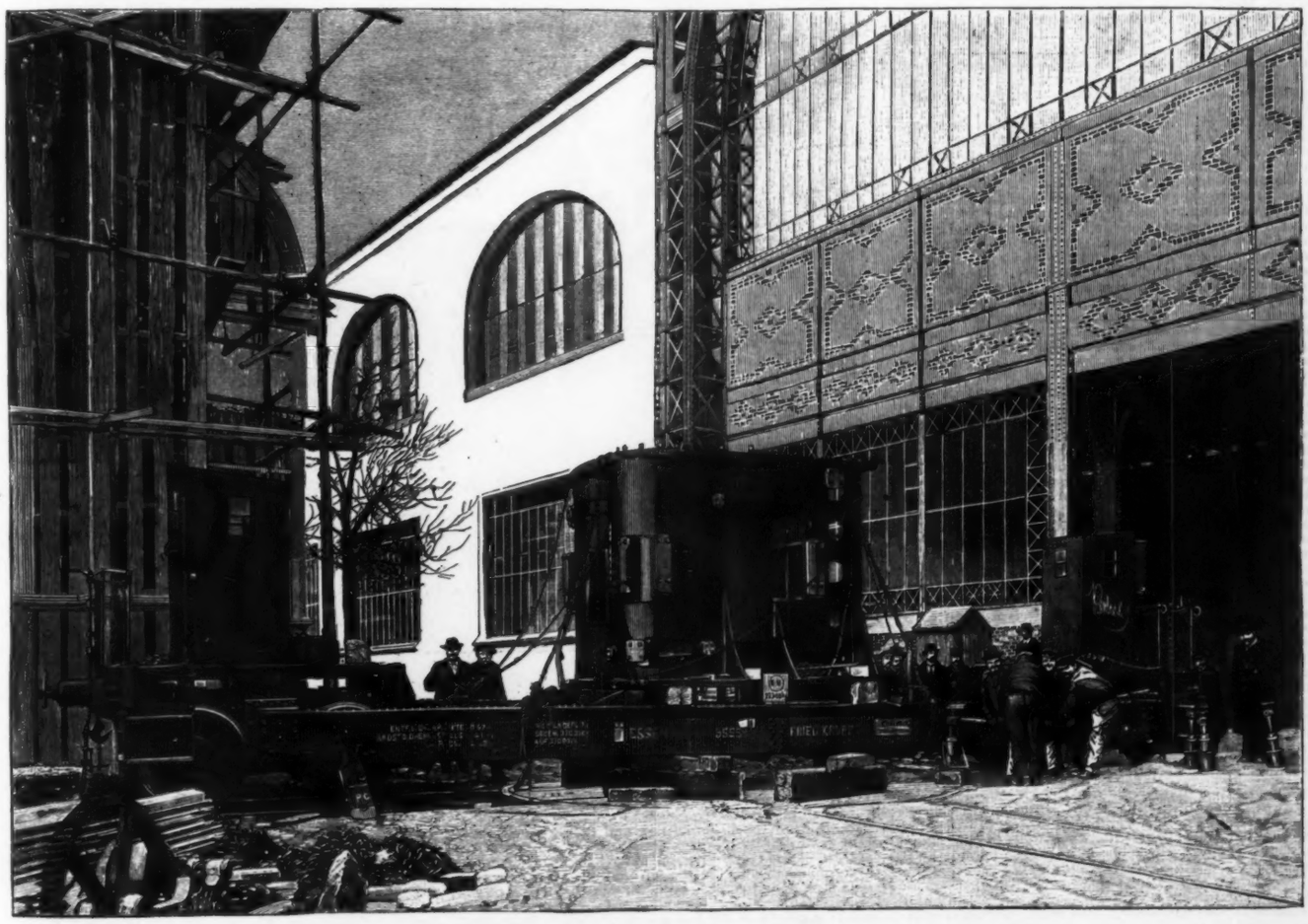
It is undoubtedly to the Siemens and Halske Company of Berlin that is due the first prize for punctuality. This establishment is installing in the electricity section a steam driven, triphase current dynamo capable of furnishing 3,000 horse power. This machine will be the most powerful and imposing one of all that the Exposition is to reveal to us. While co-operating in the production of the electricity required by the great system of cables, it will furnish directly to the German annexes the force necessary to actuate motors of 200 horse power.

It was some weeks ago, that the parts of this gigantic machine, carried by twenty-two cars, arrived on the spot and that the mounting was begun. The foundation plate consists of two pieces, each of which weighs 62,700 pounds. The crane used for mounting, which likewise was sent from Germany, had been constructed for only 55,000 pounds. M. Van Nes, engineer of the Siemens Society, was therefore forbidden to use it for the unloading and putting in place of these two huge masses. No notice, however, was taken of the injunction, and the crane behaved splendidly, bending scarcely half an inch under the extra weight. The great German dynamo of 1900 is now ready to operate.

The deplorable state of the highway, due to an exceptionally rainy season, spoils the aspect of the Exposition to those who visit it in detail. When it is possible to stand at a little distance, and at a slight elevation, the spectacle changes character. The ugly features disappear, and we no longer see the chaotic jumble that we observe from below. The Exposition reveals itself in a new light, and the arrangement of it can be better appreciated.

The slope of the Trocadero is particularly muddy. The Orientalism of the structure struggles with and is buried in a sticky mud. And yet, observed from above, over the right wing of the palace, the panorama is really handsome. We discover an entirely new city fantastically built upon the two banks of the river. In the foreground is a bold scaffolding, that of the tower which will dominate the pavilion of Cambodia; below in a confused mass of trees, are the French colonies—Indo-China, the Ivory coast, Senegal and the Soudan; farther away and to the left, are the Tunisian and Algerian palaces, entirely white and surmounted by cupolas; and farther off still are the Dutch Indies and the English colonies. Opposite, upon the other bank of the river are seen the Woman's Palace and the immense halls of the Champ de Mars, the fan-shaped Palace of Electricity, and the panorama of the world, etc., etc. Afterward, toward the left, comes the interminable frame work of the Palace of the Armies of the Land and Sea, which will be longer than the Trocadero. Then, beyond the Alma Bridge, we observe on,

SOME FRAGMENTS FROM THE PALACE OF INDUSTRY.



REVOLVING A 46-FOOT KRUPP CAR UPON A TURNTABLE 16 FEET IN DIAMETER.

one side, the pavilions and palaces of foreign powers, and, on the other, the Palace of the Congresses and of the city of Paris surrounding the conservatories of horticulture; and finally, the Grand Palais of the Champs Elysees and its glass dome. The entire new Exposition is embraced in this panorama, along with all that remains of preceding expositions—the Trocadero of 1878, the Galerie des Machines, and the Eiffel Tower.

The mysterious part of the Exposition is the Palace of Electricity and Water. Even with a general plan before one's eyes, it is difficult to imagine what its aspect will be. For the moment, it resembles one of those spark-fenders that open out like a fan. The earthwork of the Château-d'Eau, which is to precede it, is not yet finished. Deep trenches, tracks upon which small cars run, a host of girders, props and planks are all that the eye distinguishes.

There was a great excitement on the Champ de Mars a few weeks ago, when a car 46 feet in length and weighing, with its load, 46 tons was sighted. The question was, how it was to reach the section that awaited it, in view of the fact that the turntables of the Exposition are but about 16 feet in diameter. How the difficulty was surmounted is shown in one of our illustrations. The huge mass, after being drawn upon the turntable was lifted by jacks and then allowed to rest upon an improvised support formed of joists. In this way, it was possible to make a quarter of a revolution, after which the car was lowered to the rail in the direction required. This car belonged to the celebrated Krupp establishment of Essen. It was constructed for the carriage of heavy guns, and was used in the case under consideration for bringing to the exposition the cylinder of the great German steam dynamo that we have already mentioned.—For the foregoing particulars, and accompanying engravings, we are indebted to L'Illustration.

PLAN OF THE PAN-AMERICAN EXPOSITION.

The hand of the artist has labored without restraint in arranging the grounds and grouping the buildings for the great Pan-American Exposition, to be held at Buffalo in 1901. The plan has been completed after protracted and painstaking study of the grounds and their surroundings, and with a keen appreciation of all the requirements of an Exposition upon the scale of magnificence here contemplated. The completed work will be a masterpiece, in which the designer of buildings and the landscape architect will alike share the honors. American architectural genius has, indeed, here produced glorious results. If one were to see only the exterior of this splendid Exposition he will find himself abundantly repaid for his visit to Buffalo in the Pan-American year.

The Exposition grounds include 350 acres, of which 133 acres are improved park lands, a part of Delaware Park. The grounds are about 1 mile from north to south and ½ mile from east to west. Their situation is in the northern part of the city, accessible from every direction. The park lands form the southern part of the extensive grounds, and are pronounced by expert landscape architects to be among the most beautiful in the world. The trees and shrubbery in wonderful variety, the romantic footpaths leading in all directions among the thick foliage, the loveliest of lakes, on whose surface numberless swans and other water fowl of immaculate plumage are constantly at sport, the wide reaches of lawn and the rich embroidery of flowers, everywhere to be seen, all combine to refresh and restore the mind of him who tarries within these delectable precincts.

The visitor who approaches the Exposition from the south will enter the grounds on Lincoln Parkway, a broad, beautiful, shaded boulevard. Once inside the gates, the station of the intramural railway, which encircles the grounds, is at its left. But the walk is quite as tempting to the sightseer. Nature has been assisted with consummate skill by the landscape architect, and here she presents her varied colors with the grace and refinement that years of culture have given her. Presently, the views widen and the water scenes meet the eye. On the right is the refectory. The lake is dotted with boats. On the left is the Albright Art Gallery (Fig. 1 on the diagram), presented by a Buffalo citizen, who has taken this opportune time to make the city a magnificent gift. It is a permanent building, the home of Buffalo's best public art treasures, and serving the purpose as the Art Building for the Exposition.

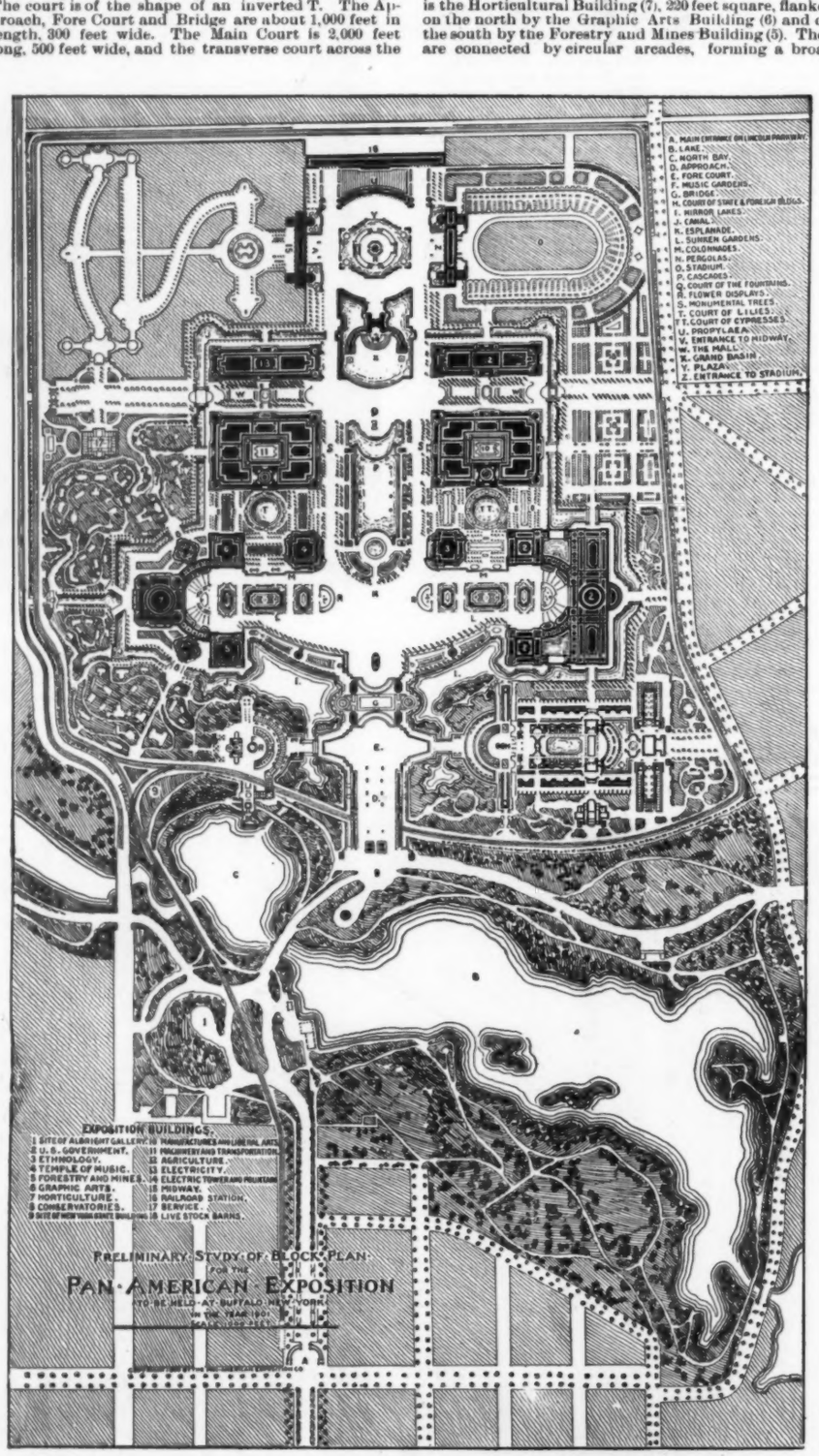
The sightseer now crosses a bridge that spans a narrow channel between the lake (*B*) and the North Bay (*C*). He is already obtaining glimpses of the stately buildings that rear their domes and pinnacles far above the surrounding objects. But, taking the objects of interest as they come—a winding path leads around the shore of the North Bay to the permanent building erected by the State of New York (9) in conjunction with the Exposition directorate. It is to be the permanent home of the extensive, valuable and interesting collection of the Buffalo Historical Society. Rather than cross the intramural railway tracks on the small bridge in the Music Gardens (*F*), it is best to retrace one's steps to the Approach (*D*). Here it is well to remain a few moments to examine the marvelous and exquisite panorama somewhat in its details. It is a picture to be seen but once in a lifetime, and always thereafter remembered with supreme satisfaction. Words are indeed but weak symbols in the presence of such surpassing magnificence. The majestic and lofty proportions of the great architectural creation forming the main group of Exposition buildings must deeply impress any visitor who stops to drink from this exhaustless fount of beauty.

As one comes to the Fore Court, *E*, the view still broadens. The buildings seem more lofty. Their rich coloring and elaborate decoration begin to touch the vision with their attractive lines.

Directly east of the Fore Court is the great Court of the State and Foreign Buildings, *H*. This extensive group in itself constitutes an Exposition where much time may be profitably spent. The Court is about 1,000 feet long and contains many buildings representing the leading States and nations of the three Americas. The variety of architecture supplies a subject for study and pleasurable contemplation. The Music Gardens are directly west of the Fore Court, and will enable large assemblages to enjoy the many fine concerts to be given there.

Leaving the deep green foliage the visitor now crosses the Triumphal Bridge, *G*, to the Esplanade, *K*. In this broad open space there is room for an assemblage of 250,000 people. This will be the scene of special celebrations and notable ceremonies during the continuance of the Exposition.

The visitor is now fairly within the Grand Court formed by the main group of Exposition buildings. The court is of the shape of an inverted T. The Approach, Fore Court and Bridge are about 1,000 feet in length, 300 feet wide. The Main Court is 2,000 feet long, 500 feet wide, and the transverse court across the



Esplanade, is 1,700 feet from east to west. On either side of the Triumphal Bridge are the Mirror Lakes, *I-I*. These are a part of the grand canal which completely encircles the great group of buildings, and upon which the visitor may ride in one of the many electric launches or take a more leisurely trip in a Venetian gondola. The canal is lined with young trees and banked with grass on its outer edge. Picturesque bridges cross it at many points.

Standing on the Esplanade and facing north the great group of buildings at the right, at the extreme east end of the transverse court are those of the Federal Government (2-2-2). The main building, in which will be sheltered a greater portion of the government exhibits, is 600 feet long by 130 feet wide. A central dome rises to a height of 250 feet above the main floor, and is surmounted by a statue of Victory, 20 feet high. The lesser buildings, each 150 feet square, are west of the main building 150 feet on the north and south lines of the main structure. Curved colonnades connect the smaller buildings with the greater, forming a spacious semi-circular court opening to the west. The government exhibits will include the aquariums and ichthyological collection of the United States Fish Commission and extensive collective exhibits from the Philippines, Porto Rico and Hawaii.

At the far western end of the broad transverse court is the Horticultural Building (7), 220 feet square, flanked on the north by the Graphic Arts Building (6) and on the south by the Forestry and Mines Building (5). They are connected by circular arcades, forming a broad court similar to that inclosed by the government group. Behind the arcades are the conservatories. The Esplanade is made beautiful with fountains, sunken gardens, pergolas and colonnades.

Immediately north of the Esplanade is the Court of the Fountains, *Q*. At the right is the Ethnological Building (3), and at the left the Music Building (4), each 150 feet square. The Court of the Fountains is to be the great center-piece of the Exposition. Here the principal electrical displays are to take place. The court is to be illuminated at night with the diffused light of more than 100,000 incandescent electric lamps, the distribution being so perfect that there will be no shadows. Colors will be extensively employed to produce fantastic effects. The huge steel tower (14), 350 feet high, which stands at the north end of the Court of the Fountains, will be used in the production of ex-

traordinary electric features. One of these will be an electric waterfall 30 feet wide and of 70 feet descent; from a niche in the tower. The tower itself is of imposing design and intricate workmanship. The many fountains in the great basin of the court will be made beautiful at night by means of electric lights of all colors.

The very extraordinary electrical features of the Exposition are made possible by the fact that electric power from the largest power plant in the world, at Niagara Falls, is to be provided in unlimited quantities. This power plant is only half an hour's ride from Buffalo, and is one of the great sights for visitors to the Exposition to include in their itinerary.

Opposite the Court of the Fountains are the two big buildings of the Exposition, the Machinery and Transportation Building (11), on the west, and the Manufactures Building (10), on the east. These are each 500 by 350 feet, and each has a beautiful tropical court with an aquatic pool in the center.

The visitor, proceeding northward, now comes to the Mall, a broad street shaded with poplars. To the right is the big Agricultural Building (12), 500 by 150 feet, and to the left is the Electricity Building (13), of the same general proportions. East of the Agricultural and Manufactures Buildings are the Live Stock Exhibits (18). About ten acres are devoted to these. West of the Machinery and Transportation Building is the Service Building (17), the headquarters for all the Exposition officers and the departments of public service that are required on the grounds.

The massive steel tower (14), already mentioned divides the Court of the Fountains from the Plaza. It stands in a large aquatic basin, and a picturesque bridge enables the visitor to reach it from the Plaza. In the tower, at the height of 70 feet, is a large restaurant. There are promenade floors at various heights, and a balcony near the summit, from which a bird's-eye view of the Exposition, the city, Lake Erie, Niagara River and the open country may be obtained. All the floors are reached by means of elevators.

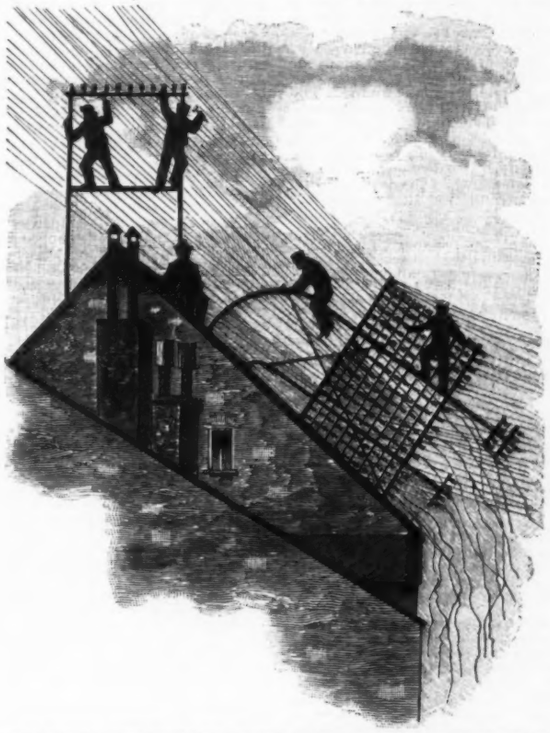
The Plaza, *Y*, is 500 feet by 350 feet. Standing at the Tower Bridge, at the right, is the Stadium Building, *Z*, 341 feet long by 52 feet wide, with towers 164 feet high. This ornate building forms the entrance to the Athletic Field or Stadium, *O*, where 25,000 people may be seated to witness the high-class athletic contests to be provided. The athletic carnival of 1901 is intended to be the greatest ever given in America. The Stadium covers about ten acres, and resembles in a general way the one erected at Athens a few years ago. It contains a quarter-mile running track and ample space within for exhibitions of skill and feats of strength. The entrances are made large so as to admit floats, etc., as the Stadium is to be used for certain pageants, exhibits of automobiles in operation, the judging of live stock, agricultural and road machinery.

On the west side of the Plaza is a large restaurant building, *V*, of the same dimensions as the Stadium entrance. This forms also the entrance to the Midway, to which twenty acres of space are devoted. The plan of the Midway is somewhat the form of an anchor with a serpentine street and an extra cross street. The large number of applications for space in the Midway has enabled the director of concessions to choose entertainments possessing exceptional novelty and merit.

At the north side of the Plaza is the Propylea, *U*, consisting of two monumental entrances connected by a curved colonnade forming a highly ornamental screen and separating the railway station from the Exposition. It is at this station that the steam railway trains from all parts of the country will discharge such of their passengers as desire to go direct to the Exposition. Electric cars will connect for all parts of the city.

Whether the Exposition is approached from the north or south the effect is impressive and awe-inspiring. The general style of the buildings is that of the Spanish Renaissance, modified to suit the character of an Exposition. There is a generous use of color, the red roofs and tinted walls giving the completed work a festival aspect. Domes, lanterns, pinnacles and statues, waving flags and streamers, make gay the sky line. The facades of the buildings are everywhere broken with elaborate architectural features, and arcaded effects are much used throughout the vast group. There are more than twenty large buildings and massive architectural works, besides the numerous State and foreign buildings, buildings for special exhibits, public comfort and other purposes. The extensive use of trees, shrubs, flowers, and aquatic pools relieves the severity that is usually encountered in exposition groups.

The buildings will all be abundantly filled with the most curious and interesting exhibits, representing the latest and best achievements of the civilization of the Western hemisphere. The profound educational value of the Pan-American Exposition at Buffalo in 1901 cannot be gainsaid.



REPAIRING TELEPHONE WIRES AND POLES IN BRESLAU, AFTER THE RECENT ACCIDENT.

ELECTRICITY BUILDING.

Elaborate designs have recently been completed for the Electricity Building for the Pan-American Exposition, to be held at Buffalo, N. Y., May 1 to October 31, 1901. Displays of all kinds in the practical and artistic uses of electricity, together with complete exhibits of electrical machinery and appliances are to be conspicuous features of the great Exposition.

The designs contemplate a very handsome and commodious building. The structure is to be 500 feet from east to west and 150 feet wide, giving an exhibition space of 75,000 square feet.

The south façade fronts the Mall and the north fronts the Midway. The east end is toward the massive Electric Tower, while the west end faces the Grand Canal. The building is long, low and inviting. The designs of the façades shows artistic grouping. The openings of the pergola-like loggias, placed at frequent intervals, present a delightful effect, showing more and more of the reveals of the pilasters and openings as the eye travels to the end of the building farthest away from the observer.

There is a pleasing ending at each corner of the building, with a low-domed pavilion tower, and the building is interrupted at the center by the double-towered entrance. This entrance, wide and high, is spanned by an ornamental arch and supported each side by columns. The towers also have minor entrances through them.

The connecting work between the towers, the towers themselves, the pavilions at the corners of the buildings, and similar places, are to be brilliantly illuminated and made gay with banners and flags.

The model relief work of the building is of choicest design. The general ornamentation of the building is to be frescoes in an interesting mixture of reds, greens and yellows. The general color scheme follows that of the Machinery and Transportation Building and other groups of buildings of the Exposition. The building was designed by Green & Wicks, of Buffalo.

AN EXTRAORDINARY TELEPHONE ACCIDENT.

FOR the first time since its installation, the telephone system of the city of Breslau was so severely crippled that more than half of its 10,000 wires were rendered useless.

The accident was due entirely to natural causes. The layer of ice which, during the cold weather, had accumulated on the telephone wires, grew thicker and thicker; the wires sank lower and lower. Not only were many wires torn from their fastenings, but even the heaviest and strongest iron poles were bent.

The destruction was greatest at the University Bridge, extending across the Oder.

Here, there were four strong poles with heavy cross-trees, to which the wires running across the bridge were secured. The four poles under the mass of ice were bent over so far that the wires completely blocked the roadway. Two poles on the shore of the river, the one located on the roof of the university, the other on the Oder watch-tower, broke down similarly. Not a support for a single long wire withstood the strain. Even a heavy pole near the central station gave way; but in a few hours linemen were already at work repairing the injury. The annexed sketch, made by a contributor to the Illustrirte Zeitung, shows both the seriousness of the damage sustained and the method of remounting the fallen supports and poles.

The wires which fell over the trolley cables of the entire electric street-car lines were a source of constant danger. Several horses were killed by electric shocks; but fortunately no human being lost his life.

THE COST OF ELECTRICITY FROM ISOLATED PLANTS.

IT is generally assumed, says The Engineering Magazine, that electricity can be supplied to buildings more cheaply than it can be generated by isolated plants; but that this is not always the case is shown in a carefully prepared paper read before the American Institute of Electrical Engineers by Mr. Percival R. Moses. Mr. Moses has collected information from more than 100 buildings of various sizes and types, and from these he has selected those from which the information was furnished with such a degree of detail as to render the conclusions reliable. The buildings selected include hotels, office buildings, loft buildings, department stores, and apartment houses, all in the city of New York, and since liberal access to the books of the estab-

lishments were permitted, the data are of much interest. In the investigation of the buildings, the hourly variations in the demand for light and power were plotted in the form of curves, and in each case a proportional allowance made for depreciation, interest, and other fixed charges. A typical building was taken in each case, and as these cases include actual records of the cost of supplying the same buildings, under the same conditions, with electricity, both from their own isolated plants and by the central station, it certainly appears as if the comparisons have been made upon a fair basis. In considering the isolated plant it must be remembered that in nearly, if not all, such buildings a steam-power plant must be maintained in any case, or at least steam must be used for heating, and if the steam-power does not provide sufficient exhaust steam to warm the building, live steam must be used. The installation of an isolated electrical plant is, therefore, only a partial increase in operating expense in such cases, and not so great as it would be if the entire power plant had to be placed solely for the operation of the electrical machinery. We give here only the conclusions which Mr. Moses draws from each building considered by him, and the full data in each case will be found in his original paper. Taking a table which Mr. Moses has prepared for buildings using approximately from 825,000 kilowatt-hours per annum down to 40,000 kilowatt-hours, he shows that the cost per kilowatt hour for isolated plants are as follows:

Large hotel	1·66 cents.
Small hotel	2·45 "
Apartments	4·70 "
Department store	2·85 "
Small store	4·10 "
Large office building	4·37 "
Small office building	5·06 "
Loft building	2·60 "

When it is understood that the charges by the central station company, taken from the published reports, are, on an average, 10·6 cents per kilowatt-hour, and that the cost of production is about half this, it appears that under existing conditions in New York the private consumer can generate electricity at about the same cost or even less cost, than the central company, and that there is a manifest economy in the installation of the isolated electric plant.

THE VALUE OF PARA RUBBER.

"Planters and traders are specially pleased to deal with a product like India rubber," says The Pall Mall Gazette in an article on the industry in Para. "It does not lose its value, while the value of many other products is decreasing through similar production in other countries. Thanks to its splendid quality, the India rubber of Para has very little to fear from competition. True, there are in many other countries many plants belonging to different families and which would perhaps give as good a product, but none of those plants are as productive as the plants of the Amazon basin. It has been said that forests of India-rubber-yielding trees might give 50 per cent. more with some cultivation. It is obvious that it might lead to a more agreeable work, as the workingmen would not be exposed to such perilous journeys, they could live nearer their employment, they could more easily follow hygienic principles, and, further, the treatment of the men stricken with fever would become far better. One thing is certain, a plantation of India rubber does pay, and even when it is necessary to plant entirely a surface where there had not been before India-rubber-yielding plants. But, as a rule, it would be only necessary to complete the many groups of India-rubber-yielding trees which already exist. For a value of about £15 from 100 to 150 trees can be hired for the time of the harvest. Generally, this value is paid in produce, and amounts for those 100 to 150 trees to about 16 kilogrammes. In order to avoid the complete extraction there are generally not over sixteen liters of milk to be taken from each tree. This might appear to be but little. However, it must be remembered that the forest or plantation surface is very great, and that consequently very large quantities are produced."

SUGAR FROM WATERMELONS.

A farmer and gardener named Hanz, of Bowling Green, Ky., has recently made an excellent quality of sirup from watermelons, according to The Irrigation Age, which states that he will shortly attempt to convert some of the sirup into sugar, and expects to be successful. The same paper gives the following report of an interview with him:

"From 18 melons, weighing from 20 to 25 pounds, we made two gallons and one pint of sirup. We cut the melons in halves, cut out the pulp, ground it in a cider-mill, and pressed out the juice. We boiled the juice in porcelain kettles on the kitchen stove for twelve hours. With a cider-mill and hot air or steam evaporator, two men can make 25 or 30 gallons of sirup per day. At the above figures it would take about 270 melons to make 30 gallons of sirup, worth $15. Melons would be worth at wholesale about $5 or $6, and it would take two or three days to haul and sell them at market. With a mill and an evaporator in the melon patch, a farmer and one or two hands could realize 100 per cent. more by making them into sirup and feeding the refuse to hogs, cattle, horses, and chickens, which eat it greedily."

SOLUBILITY OF COPPER IN GELATINE SOLUTION.

A. Lidof finds that when a spiral of bright metallic copper is suspended in an alkaline solution of gelatine, the liquid acquires a violet tint in twenty-four hours and becomes darker in a longer period, the copper rapidly losing weight, equivalent in forty-seven days to 3·4 per cent. When the violet solution thus obtained is heated under pressure, or is treated at ordinary temperatures with formaldehyde, it is decomposed, the precipitate thrown down being a compound of copper with organic bodies. To the formation of this soluble organic copper compound, the author attributes the so-called "biuret" reaction.—Bull. Soc. Chim., 24, 33, after Journ. Soc. Physiol. Chim.

TRADE NOTES AND RECEIPTS.

Express Copy Ink, with which copying can be done direct without moistening and any arrangement whatever, is composed, according to Vinceneuse and Goulhard, of ordinary ink 1,000 parts, glycerine 600 parts, honey 200 parts, rock candy 200 parts, alcohol 100 parts, molasses 50 parts.—Bulletin Général de Therapeutique.

Substitute for Phosphorus on Matches.—G. Graveri recommends persul focyanic acid = $H_3(CN)_3S_3$, as meeting all the requirements to take the place of phosphorus on matches. It is resistive to knocks and friction, readily friable, and will miscible with other substances; entirely non-poisonous and cheaper than phosphorus. Rich sources of the raw material for the production of this preparation are the Laming's masses from the purification of illuminating gas, the ammoniacal liquors, residue of the soda manufacture, and other materials.—Chemiker Zeitung.

Formation of Acetylene Copper.—A. Grittner describes the following experiment: If perfectly pure acetylene is sent into an ammoniacal solution of copper sulphate solution, no change takes place. But if bright sheet copper or copper wire is dipped into this solution, a red acetylene copper layer forms immediately. In case the experiment is continued long enough, the acetylene copper peels off in scales from the copper and floats on the liquid. If the copper surface is washed off carefully and heated after drying, the adhering acetylene copper will explode.—Bayerisches Industri und Gewerbeblatt.

Production of Indigo-White in a Constant and Concentrated Form.—Differing from other dyeing processes there is used in vat-dyeing as starting material a substance, indigo-white, which is not found in the market, but has to be previously prepared in a special operation by reduction of indigo-blue. Experiments have been made, to place indigo-white on the market as such, but the results have not been successful. The desired end is attained, however, by isolating indigo-white from the vat by evaporation for precipitation with acids, and mixing the indigo-white thus isolated with calcium hydrosulphite or stirring it together with alkaline hydrosulphites or other reducing agents such as tin salt, with or without addition of alkalies. A vat containing 3 kilos of indigo-white as alkaline-salt dissolved in 100 liters of water, is, for instance, acidulated with hydrochloric acid, the separating indigo-white is squeezed off, stirred with 3 kilos of calcium hydrosulphite and kept in closed vessels. For the precipitation of indigo-white, an admixture of formaldehyde or benzaldehyde is also of advantage. The indigo-white thereby separating in a permanent form, possibly with formation of aldehyde compounds.—Fabren Zeitung.

Treatment of Oils with Ozone.—Ozone has lately been successfully employed for the purification of linseed oil, olive oil, palm oil, colza, etc. The purifying process for linseed oil consists in passing ozonized air into it. The oil thus loses its water and all impurities, does not suffer any loss, retains its properties and thickens readily.

The air to be ozonized is driven by a pump through a drying-chamber, in which there are plates covered with burnt lime. Next it is passed through the ozonizers, and by a compressor brought into a firm iron reservoir, from which it is distributed into the various purifying apparatus. For refining one ton of oil, 310-315 cubic meters of ozonized air are employed on an average. According to Dr. Lew Kowstsch, this quantity of air can be produced with Yarnold ozonizers at a cost of about 2 francs. In small works, treating about 5 tons of oil daily, the costs, including sinking fund and expense of maintenance, etc., would not exceed 9 francs per ton.

In a similar manner the purification of other oils is carried out. Advantages of this process are: Decrease of waste, quicker refinement, and production of handome merchandise.—L'Industrie Eletrochimique through Elektrotechnische Zeitschrift.

Employment of Aluminium in the Steel Industry.—The admixture of aluminium in the manufacture of steel varies according to the nature of the steel to the amount of gas present, to the temperature during the casting and to the size of the piece cast. The amount to be employed for Siemens-Martin steel is 56 to 140 grammes at most, per ton. The addition may be made in the shank, or better still, when the metal is poured into the molds. Bessemer steel may receive 30 to 80 grammes more without injury. The main advantage of this admixture consists in that it increases the purity of the ingot in the upper part, hence reducing the waste aluminium used in small quantities, lessen the boiling of the steel during the casting, hastens the cooling and prevents the rising of the metal. If the above additions are exceeded, the steel solidifies quickly, but contains many blisters.

The mixing of the aluminium and the steel takes place without difficulty and also favors the alloyage of nickel and other metals with the steel. The casting thus produced with soft Siemens-Martin iron is very handsome and possesses a tensile strength of 32 kilogrammes per square millimeter, while the same metal without aluminium attains only 16 kilogrammes. The extension in both cases remains proportionally the same.

Aluminium is a strong reducing agent: 100 parts (by weight) of oxygen combine with 114 of aluminium, 110 of silicum, and 350 of manganese. Besides, there is no free aluminium in the steel, if no more oxygen is present; silicium and manganese show a different behavior. Moreover, aluminium is a cheap reductive. For one ton of steel 20 marks worth of silicum would have to be employed while 1·20 mark is sufficient for aluminium.

Preferable for use is pure aluminium, still some employ ferro aluminium—5, 10, and 20 per cent. of aluminium—but in that case the alloy must contain neither sulphur nor phosphorus.

Aluminium is also used with advantage in the smelting of iron—0·5 to 1,000 grammes per 1,000 kilogrammes. It facilitates the fusion and imparts to the iron a closer grain. The chemically bound carbon is converted into pure graphites and the cooling tendencies of the metal are lessened. 2 per cent. of aluminium will also diminish the contraction or shrinkage of cast iron.—Oesterreichische Zeitschrift für Berg-und Hüttenwesen.

SELECTED FORMULÆ.

Transferring Photo Resists to Steel for Decorative Etching.—A continental technical writer describes an interesting development of photographic methods of decorating metal, and more particularly steel. The first necessity for the method now detailed is a specially deep intaglio plate, such extra depth being required as is essential in the ordinary methods of transfer printing on earthenware or on glass, and in direct printing (from intaglio rollers) on textiles. This intaglio plate of extra depth is made from a photographic positive transparency. We assume the positive is grained by the use of the ruled screen, and the fish glue process of sensitizing the metal is employed, but before etching the copper plate it is dusted in the graining box as ordinarily used for the Klic process of photogravure. In this way considerable depth may be obtained, together with that roughness of the hollows which is so essential for the proper holding of the printing ink or resist. The ink or resist sold in this particular case is a waxy mixture, which is practically solid when cold, so obviously the plate must be warmed for the operation of filling in. The excess of ink or resist is now scraped off as completely as possible with a spatula or other suitable tool, and when the plate is cold a final cleaning is given with a tuft of cotton moistened with alcohol. A print is now made on transparent lithographic transfer paper, and this is transferred to the slightly warmed steel surface, much in the same way as pottery transfers are put down. The paper being soaked off, all is ready for etching. This method is said to be easy after a little practice, and the adhesion of the resist to the metal highly satisfactory. Additions by hand or retouching may be readily made. A simple solution of sulphate of copper may be used as a mordant.

Etching on Steel.—Nitric or hydrochloric acids, or mixtures of the two, are employed as the "acid" in marking or etching on steel. The following are among the methods employed:

1. Glacial acetic acid, four parts, is mixed with absolute alcohol one part, and nitric acid (sp.gr. 1·28) one part. Allow the acetic acid and alcohol to remain for half an hour, then add nitric acid carefully. Etch from one to fifteen minutes. Of course, the parts you wish to protect from corrosion must be covered with beeswax, tallow, or some similar substance.

2. Cover the surface with a thin coat of asphaltum varnish of fine quality, then cut the design through the surface of the steel and etch with a weak solution of nitric acid in water; finally, wash with hot water and remove the asphaltum with turpentine.

3. Clean the steel and cover evenly with wax, cut the lines with a steel point through the wax, and pour on the following etching fluid: Pyroligenious acid, four ounces; alcohol, one ounce; nitric acid, one ounce by measure. Or use iodine, one ounce; iron filings, one-half drachm; water, four ounces. The etching fluid is to be removed as soon as the metal is sufficiently etched.—Process Review.

Ravigotte Mustard.—

Parsley	2 parts.
Chervil	2 "
Chives	2 "
Cloves	1 "
Garlic	1 "
Thyme	1 "
Tarragon	1 "
Salt	8 "
Olive oil	4 "
White wine vinegar	128 "
Mustard flour, sufficient.	

Cut or bruise the plants and spices, and macerate them in the vinegar for fifteen or twenty days. Strain the liquid through a cloth and add the salt. Rub up mustard with the olive oil in a vessel set in ice, adding a little of the spiced vinegar from time to time until the whole is incorporated and the complete mixture makes 384 parts.

Artificial Cider.—The following when properly prepared, makes a passable substitute for cider, and a very pleasant drink.

Catechu, powdered	3 parts.
Alum, powdered	5 "
Honey	640 "
Water	12,800 "
Yeast	32 "

Dissolve the catechu, alum and honey in the water, add the yeast, and put in some warm place to ferment. Fermentation should be carried on in the manner and under the precautions so frequently described in these columns (i. e., the container should be filled to the square opening, made by sawing out five or six inches of the center of a stave, and the spume skimmed off daily as it arises). In cooler weather from 2 weeks to 18 days will be required for thorough fermentation. In warmer weather from 12 to 13 days will be sufficient. When fermentation is complete add the following solution:

Oil of bitter almond	1 part.
Oil of clover	1 "
Caramel	32 "
Alcohol	192 "

The alcohol may be replaced by twice its volume of Club House or other good bourbon whiskey. A much cheaper, but correspondingly poor substitute for the above may be made as follows:

Twenty-five gallons of soft water, 2 pounds tartaric acid, 25 pounds of brown sugar, and 1 pint of yeast, are allowed to stand in a warm place, in a clean cask with the bung out, for twenty-four hours. Then bung up the cask, after adding 3 gallons of whiskey, and let stand for 48 hours, after which the liquor is ready for use.—National Druggist.

Filling for Dry Cells.—

Calcium chloride, crystallized	30 parts.
Calcium chloride, granulated	30 "
Ammonium sulphate	15 "
Zinc sulphate	25 "

The mixture is said to have proven valuable for electric conduits.—Neueste Erfindungen und Erfahrungen.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

The Coal Famine in Germany.—It is now recognized that the prosperity of the iron and steel industries in Germany has become seriously jeopardized by the scarcity of coal, especially the qualities adapted to coking for blast-furnace fuel, says Frank H. Mason, Consul-General at Berlin. This will inevitably restrict the pig-iron output of the current year, which during the final eleven months of 1899 increased to 7,406,171 metric tons, as compared with 6,740,379 tons for the corresponding period of 1898.

In the coal districts of the Saar and Upper Silesia, where the supply of good coking coals is always limited, attempts are now being made to utilize coals of inferior coking qualities by previously stamping, with special machinery, the coke-oven charges. While this process does not produce good blast-furnace coke, it does produce a fuel that can be fairly well used for other metallurgical purposes, and thus reduce the demand for the precious coke of high quality.

In consequence of the shortening supply of pig iron, all other cognate materials have advanced in price, so that old iron now commands 81 marks ($19.27) per ton; lathe shavings, 76 marks ($18.08) per ton; and old rails, 107 to 112 marks ($25.46 to $26.65) per ton. All mills which manufacture hoop iron, girders, boiler and ship plates, and all kinds of structural iron are filled with orders and begging for more time for deliveries.

The situation has been aggravated by the extreme scarcity and high prices of coal—especially anthracite and gas coals—in Great Britain, which has for the moment practically cut off what has been hitherto an important source of supply for Germany.

These circumstances combine to form a new and important opportunity for the coal exporters of the United States. Letters are received at this consulate from importers of English anthracite and gas coals, complaining of the meager supply and high prices, and asking to be put into communication with American exporters of those grades. If, in addition to the enormous quantity of coal now being consumed in the United States, there remains any considerable surplus for export, and the conditions of freight are not prohibitory, the present season offers a rare and fertile opportunity to establish in the German market the standard grades of American anthracite and gas coals.

Germany imported during the first eleven months of 1899, 5,760,017 tons of anthracite and bituminous coals, of which 4,524,495 tons came from Great Britain; the remainder, from Belgium (547,732 tons), France (7,712 tons), Holland (107,627 tons), and Austria-Hungary (566,093 tons). For reasons which are obvious and likely to be more or less permanent, this large import from Great Britain is now seriously restricted; and the degree and duration of this restriction will form the measure of the opportunity which is now offered to the coal exporters of the United States.

German Agricultural Implements in Russia.—The published announcement that the American exhibitors of agricultural machinery at the Paris Exposition would, after the close of that display, transfer their exhibits to a special exhibition of machinery to be held at Moscow during the autumn of the present year has suggested a counter move on the part of the alert and enterprising "Central Union of German Industrials," which safeguards so actively and efficiently the interests of its members, says Frank H. Mason, Consul-General at Berlin.

This association has issued to all German manufacturers of agricultural implements and machinery a circular, in which it is proposed that they shall forestall the American exhibition at Moscow by transferring to some well-chosen city in Russia the machinery and implements of German manufacture which are to be exhibited at the forthcoming exposition in Posen, from the 7th to the 13th of June next. Posen is located in Eastern Silesia, near the Russian frontier, so that a transfer of the whole German machinery exhibit there to Moscow, Wilna, Minsk, or St. Petersburg would be easy and inexpensive.

The circular points out the serious danger which is threatened by the American exhibition to the present large and important German trade in agricultural implements with Russia and asks whether, under existing circumstances, the German makers feel disposed to send their exhibits from Posen to a second exposition in Russia; if so, where and for how long a period should this exposition be maintained; and, finally, what part of his proportionate share of the entire cost of such an enterprise each exhibitor is willing to contribute.

Answers to the interrogatories are to be sent in not later than February 20, after which date the Central Association will ascertain what part of any deficit in expenses will be paid by the Imperial German government, and will then decide whether or not the proposed scheme shall be carried through. It is understood that twenty-four firms and companies, including all the largest and most important manufacturers of agricultural implements and machinery in this country, have already returned favorable answers, so that it may be safely assumed that the proposed exhibition will be opened at some carefully chosen point in Russia about July 1 next, four or five months in advance of the opening of the American exposition at Moscow.

Industrial Development in Siam.—Rice cultivation is the principal industry of Siam, says Hamilton King, Consul-General at Bangkok. There are 26 rice mills in Bangkok, and, although the first one in the country was started by an American, none are owned by Americans to-day. Four are European and the rest are owned or managed by Chinese. Some of the Chinese firms have a very large capital. Seven of the mills have their own electric-light plants, one of which was furnished by an American house; all the other supplies and the rice-milling machinery used here have come from England and Scotland.

A few years ago the paddy or rice husk, which is used for fuel, was so cheap that much waste was permitted in its consumption; now, however, the rapidly increasing price of fuel has created a good market for this husk, and efforts are being made to economize by introducing more improved methods of combustion.

Teak wood is the next most important industry of the country, and there are ten large steam sawmills and many smaller handmills in the city for the manufacture of teak lumber. Three of the mills have their own electric-light plants, and all of them get their machinery and supplies from Great Britain.

Twenty years ago shipbuilding was carried on quite extensively. At present, however, there are only four small docks and shipyards, and only small boats are constructed. There have been built on an average for several years past about 25 steam launches of from 17 to 30 tons burden; 30 cargo boats (craft about 50 feet in length by 13 feet beam), and 8 lorchas, or Chinese sailing craft, 110 feet in length by 22 feet beam; while hundreds of the smaller boats of all descriptions that swarm the rivers and canals are turned out every season. All supplies and machinery for this industry come from Europe.

There are four large machine shops and foundries in Bangkok; also the shops of the two railroad systems, supplies for which likewise come from Europe. The large electric-lighting plant for the city and the two power houses for the electric tram-car system obtained their equipment in Europe and the United States.

There are in the city twelve printing establishments in which English type is used and twenty-four in which Siamese printing is done. These include in their output three daily papers, periodicals, and books of all description, besides many lesser publications and much job work. The printing supplies for the city, for the most part come from Europe. The United States is now furnishing a portion, however, and American paper has within the last year made a decided hit and is just now increasing in favor.

Lubricating oils for all these manufactories are supplied by the Vacuum Oil Company and the Charles Price Oil Company, both of London. The native castor oil of this section is a vigorous competitor, selling anywhere from $12 to $14 Mexican ($5.69 to $6.64 in United States currency) per picul (133 pounds). During the last six months, the importation of crude petroleum in bulk from Russia and Borneo has been going on, and efforts are now being made to introduce it as a fuel in the factories and on the steam craft that ply in the inland waters. The efforts thus far is meeting with very questionable success and seems to promise little in the way of trade.

As a result of the gradual improvement of the streets of the city during the last ten years, very many vehicles of all descriptions are used. The extent of the city makes travel by carriage almost a necessity; hence, Bangkok is probably a long way ahead of any other city in the Far East in the use of wheeled vehicles. The demand was at first supplied principally from outside sources; but of late a local industry has been springing up, and 90 per cent. of the carriages in use are now manufactured in Bangkok. Without exception, however, they strike the American as unnecessarily heavy and clumsy. The streets of the city are perfectly level, no point for miles around being more than 3 feet above high-water mark, and, being built of brick or macadam, are most adaptable to the use of light-running vehicles of all kinds. Moreover, the native ponies, which have proved themselves best fitted to stand the trying climate, are very small, weighing only from 500 to 700 pounds, and hardly suitable for the heavy vehicles. But these little animals are used so exclusively that there are not more than thirty full-sized horses in the city. In view of these conditions, it would seem that the different styles of light-running American vehicles would prove very desirable if once introduced. The workmanship and material must be first-class to meet the climate, which changes very quickly from extremely wet to hot and dry; but if well made, there is no doubt that our vehicles would wear quite as well as the cumbersome ones now in use, while their greater lightness and beauty would win for them a place in this market.

American paints, oils, and varnishes are still unknown here; but, in view of the amount of building now in progress in the city, including the construction of docks and shipyards, as well as the rapidly growing carriage industry, there is no doubt that there is an opening here for American trade in this line of goods.

The greatest obstacles is the cost of freight, due to the repeated transshipments en route. A through line of steamers from New York to Manila, with regular sailings, would be a great assistance, necessitating, but one transshipment at Singapore, and placing American goods on an equal footing for the most part with goods from Europe. There is but one line of steamers from this port direct to Europe—the East Asiatic Line, from Copenhagen to Bangkok. The service consists of one steamer each way every three months.

The Germans are coming to the front very rapidly in Siam. Prince Henry of Prussia is here, and the last two weeks have been spent in a constant ovation to him. The Emperor of Germany from time to time by personal letters and by presents to the King of Siam has helped the German interests here very materially. England and France seem to be losing ground.

Liquid Air as an Explosive.—Ever since it was demonstrated that liquid air could be readily produced on a commercial scale, it has been hoped and expected that one of the principal uses to which it would be applied would be that of an explosive material for blasting purposes, particularly in mines, where the new explosive would have the important advantages of safety in handling and of not vitiating the air, like gunpowder or dynamite, by the gases of ignition, says Consul-General Frank H. Mason, of Berlin.

Some months ago a newspaper report announced that liquid air had been formally adopted for blasting purposes in the government coal mines of Germany, but inquiry proved that this announcement was at least premature. The fact appears to be that experiments—more or less successful—have been made, especially by Prof. Linde, of the Polytechnic High School at Munich, but no formal adoption of the new explosive by the government bureau of mining industries has yet taken place.

Among the most systematic and interesting practical experiments thus far made in this direction has been the series of tests lately undertaken by the Vienna Crystal Ice Company in the presence of experts from the Austrian technical committee for the War Department. The liquid air used in these tests was obtained from the Linde Company, at Munich, and shipped to Vienna in open flasks, provided with the Dewar vacuum jacket and packed with felt and cotton wrappings in wooden cases, with a loose cap of felt over the open mouth of each flask. When put up at the laboratory for shipment, the liquid contained 75 per cent. oxygen to 25 per cent. nitrogen; but before it had reached Vienna and was used in the experiments, it had lost about half its bulk by evaporation, and what remained contained 85 per cent. oxygen to 15 per cent. nitrogen. The absorbents used in preparing the cartridges were silicious marl (Kieselguhr) and "solar oil," and, according to the report, two methods of preparation were employed. By one process the marl and oil were mixed in a wooden vessel, and the liquid air gradually added until a stiff paste was formed, which was packed in paper cartridge shells covered with asbestos.

By the other plan, the mixture of marl and oil was put into the cartridge, which was inclosed in a lead case with a layer of felt between, and the liquid air then poured in until the paste was completely saturated. The cartridges prepared by both methods were safe and readily transportable, and their explosive power was tested by firing at the bottom of deep holes bored in rock. The results showed that while liquid air is an efficient explosive, it is less effective than dynamite, guncotton, explosive gelatin, or giant powder.

The conclusions of the military experts were concisely as follows: Both methods of preparing the cartridges were pronounced wasteful, and in consequence of the rapid evaporation of the liquid air, they must be used immediately after being prepared; beyond fifteen minutes the evaporation will so effect the cartridge that it is likely to miss fire and its strength can not be even roughly guaranteed. On the other hand, the cartridges when freshly prepared are powerful and well adapted to coal and other mining, and, while the large amount of oxygen set free by the firing of successive charges might increase the danger of explosion in the air and gases of the mine itself, the quality of the air for breathing purposes would be definitely improved.

The net conclusion to be derived from these and preceding experiments in Europe is that, notwithstanding the obvious advantages of liquid air as an explosive for mining purposes, the rapid deterioration of the cartridges and their varying and uncertain strength are obstacles so serious that, until they can be overcome, its value and application to that use will remain experimental and comparatively limited.

Consolidation of Debt of Haiti.—Minister Powell writes from Port au Prince, under date of February 13, 1900, that the Haitian government has consolidated the debt of the Republic. All outstanding claims have been collected, including the loans made by local bankers, which were guaranteed by a precentage of the revenue collected. Under the terms of the consolidation, the creditors relinquish this guaranty and receive a gold-bearing bond, augmented 10 per cent. in value bearing interest at the rate of 1 per cent. in gold per month and payable in fourteen years. This releases to the government certain duties on coffee, logwood, and cocoa which were formerly mortgaged, and provides the cash to meet the expenses for the budget, etc. It further postpones the payment for the debt for a number of years, and it is hoped, says Mr. Powell, that within this period the increased production and foreign consumption will provide the money to pay the bonds as they fall due. The agreement has yet to received the indorsement of the National Assembly as its session in April, when it is believed a law will be enacted giving the government the power to conclude this agreement.

Franco-Belgian Steamship Line to the East.—Under date of January 30, 1900, Consul Atwell, of Roubaix, writes as follows:

The French Chamber of Commerce at Antwerp has under consideration a project to establish a Franco-Belgian steamship line between Antwerp, Dunkirk (headquarters of the company), Indo-China and the extreme Orient. The project is recommended by the French minister and Consul General at Brussels, the French Ministers for Foreigns Affairs, the Colonies, and Commerce; also, by the Chamber of Dunkirk. The French Minister of Commerce says that the opening of the port of Dunkirk to direct trade with the Far East will greatly facilitate the commercial relations of manufacturers and merchants in the north of France with Asiatic markets, by relieving them of the necessity of shipping merchandise intended for Oriental trade through foreign ports. It is thought that trade with the Orient will receive great impetus by the creation of a service of ships sailing under French colors. The company now forming proposes to start with six ships of 4,000 tons, each, having a speed of 11 knots. Three of these ships are to be built in France and three abroad. The Chamber of Commerce of Dunkirk recommends that every facility be afforded the projectors of the scheme in order to insure success, as the line is regarded as imperative in the interest of French commerce and particularly desirable for Northern France.

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The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted

KRUPP CENTRAL-PIVOT GRAVITY AND SPRING-RETURN CARRIAGES FOR NAVAL ORDNANCE.

THE high-power rifle, more than any other weapon used in modern naval warfare, is the deciding factor in a sea fight. A ship may be put out of action long before the enemy has approached sufficiently to use his torpedoes or ram. This greater efficiency is due not only to the range, penetration, and explosive power of shells, but also to the rapidity of fire. Rapidity of fire has been obtained by means of an improved construction of gun-mounting and breech-mechanism. Quickness of loading, the element upon which rapid-fire in great measure depends, is secured by the use of fixed ammunition and improved breech-blocks. But facility of aiming is attained only by an easily manipulated gun-mount.

At present guns are mounted in two ways, on gravity-return and on spring-return carriages. In the gravity-return carriage (Fig. 1) the gun-barrel, together with the top carriage on which it rests, slides back after firing upon rearwardly rising ways, its recoil being checked by hydraulic cylinders. The carriage slides down by gravity on the guideways to firing position after the recoil. The recoil cylinders are located beneath the cheeks of the carriage and the piston rods are secured to the front of both cheeks. The force of the recoil is absorbed by the recoil cylinders and also in driving the gun up the inclined ways.

The carriage with its annular traverse platform is mounted on the ball-bearings of the pivot stand, which is bolted to the deck. The traverse platform supports the vertical pivot about which the piece rotates. Clamps secured to the traverse platform and clutching the outwardly projecting edge of the pivot stand prevent the displacement of the sliding carriage. Beneath this clamping ring is a worm-wheel engaged by a worm operated by a hand-wheel; the worm-shaft as it turns in its bearings rotates the piece.

The construction possesses the merit of utilizing no springs in checking the recoil or returning the piece to battery or firing position; for springs, owing to their small breaking strain, were not always trustworthy. But improved methods of manufacture have rendered the use of springs so much safer than formerly that spring-return carriages are playing the leading rôle in naval armament.

In the spring-return type of carriage, the gun is seated in a sleeve or jacket of steel or bronze, which is provided with trunnion-bearings; the gun sliding within the sleeve during and after the recoil. Guides prevent the gun turning about in its longitudinal axis in a direction opposite to that of the rifling. The recoil is checked by hydraulic cylinders and by return springs located in casings at both sides of the recoil-cylinders. The coil springs in these casings are compressed during recoil and automatically return the gun to battery after the recoil. The two spring casings and the pistons are secured to the sleeve; the recoil-cylinder is secured to a ring shrunk on the barrel immediately in front of the breech-mechanism. Recoil-cylinders and return-spring casings can be placed above or beneath the barrel or at one side. When mounted beneath the barrel (Figs. 2 and 3), they are less exposed to shot and shell. Like the gravity-return carriage, the spring-return mount rests on a traverse platform and turns upon the balls of the pivot-stand. This construction of the stand is defective, for the balls, the most delicate part of the mount, upon whose faultless operation the facility of turning the carriage depends, are rendered difficult of access. The obstacle has been, at least, partially overcome in the new Krupp rapid-fire gun by employing the auxiliary pivot shown in Figs. 2 to 5. The yoke, *A*, with its hollow pivot, turns in bearings bushed with bronze. The weight is borne chiefly by the steel auxiliary pivot, which has slight lateral play and which bears upon arched step-bearing, *f*. The pivot yoke is supported by the ball-bearings, the distance between the pivot and the step-bearing being so regulated by the thread, *g*, that the auxiliary pivot alone carries the yoke and gun. In training the piece only the slight friction of the ball-bearings has to be overcome. It is by reason of this construction that a gun weighing several tons can be swung around and trained by a single man. The supporting and adjusting screw, *g*, can be readily removed in order to repair or clean the ball-bearings.

Among the advantages claimed for the construction, is the readiness with which the piece can be lifted from the carriage. For this purpose the trunnion-bearings are opened not from above, but from the rear end, and are shut by the closure, *d* (Fig. 4), the shoulders, *e*, of which receive the force of the recoil. Lateral shifting of the closure is prevented by the rings, *b* and *c*, which are fastened to the yoke members, *a*, by four screw bolts. The inner rings, *b*, in removing the piece, are shifted on the trunnions and pulled out rearwardly from the bearings with the piece. The gun-barrel with its sleeve is lifted from the yoke by means of two shackles on the sleeve, which are hooked by tackle running along the beams of the upper deck. The guns are hung in this manner to protect them from injury while floating in the lock-chambers of canals or steaming in crowded harbors.

The small size of the stand compared with that of the gravity return carriage not only effects a saving of space on shipboard but it also enables a 15 c. m. gun, though the recoil-cylinders be mounted beneath the barrel, to be elevated 30 degrees; to attain this end it was necessary merely to cut out the pivot-yoke at *h* to receive the heads of the spring-casings. In English and French ships a 15 c. m. gun cannot be elevated more than 15 to 20 degrees.

The flat arm at the left side supports the training gear, the segment rack of which is secured to the gun-barrel, together with the traverse platform (Fig. 3). This arm, as well as its companion on the right side of the pivot-yoke, enables the shield to be conveniently fastened in place. In the spring-return carriage the shield is merely a disk of no great size. In the gravity-return carriage it is much larger, since it must protect more complicated and widely distributed mechanism.

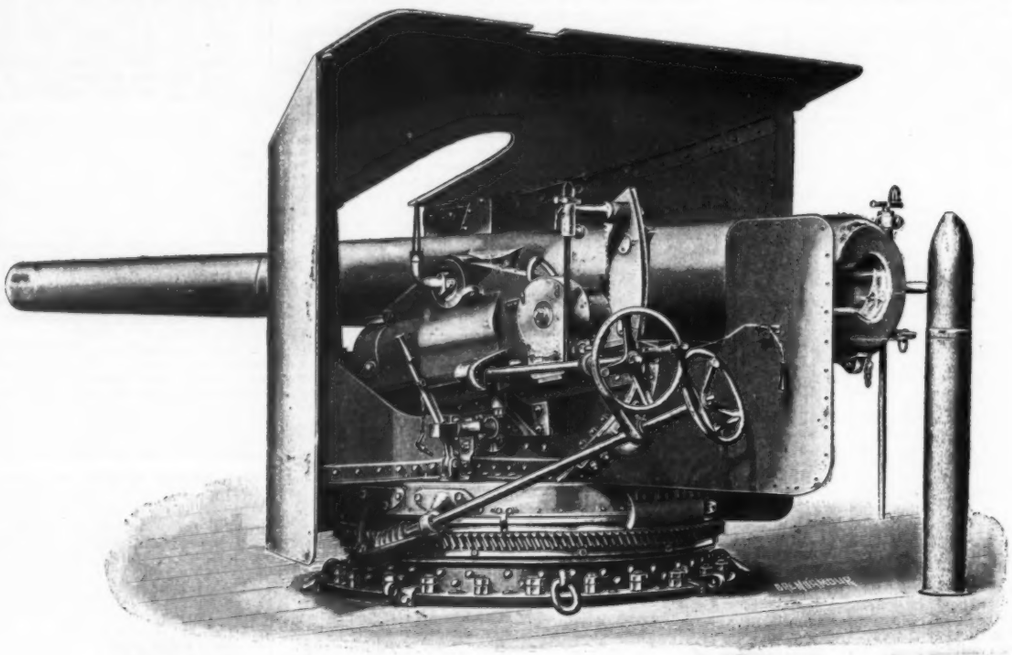


FIG. 1.—KRUPP CENTRAL-PIVOT GRAVITY-RETURN CARRIAGE.

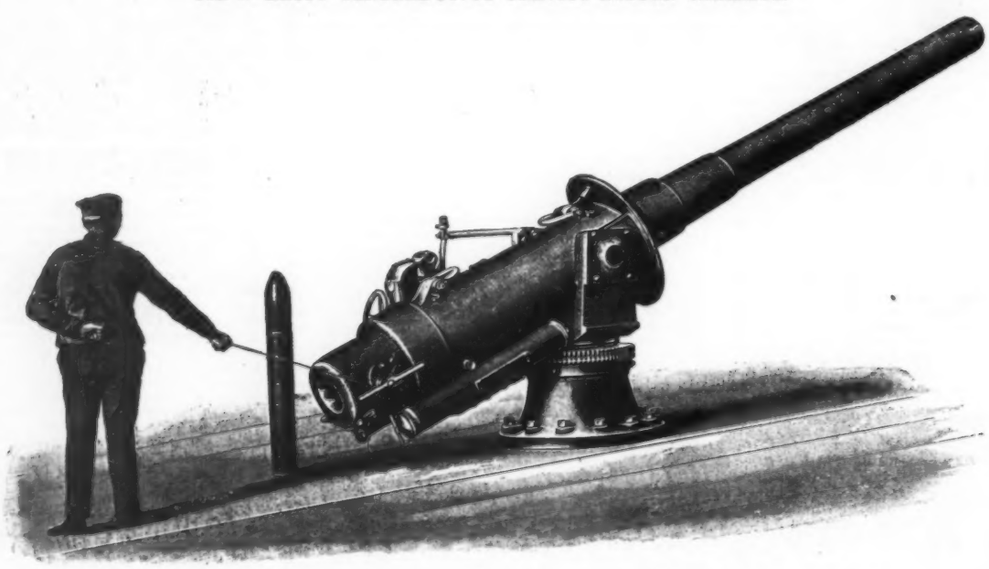


FIG. 2.—A 15-C.M. RAPID-FIRING GUN MOUNTED ON A SPRING-RETURN CARRIAGE.

The balls in the spring-return carriage are not affected by the recoil and serve merely as a bearing or support for the superstructure. The force of the recoil is transmitted to the deck entirely by the long pivot held by the clamp, *k*, secured to the upper edge of the stand. The ball-bearings of the spring-return carriage are subjected to less strain than the larger ball-bearings of the gravity-return carriage.

Our particulars and illustrations have been taken from Prometheus.

THE screw alone of an Atlantic liner costs about $20,000.

BESSEMER STEEL PRODUCTION IN 1899.

ON January 6, 1900, we estimated the Bessemer steel production of the United States for 1899 at 7,620,000 long-tons, says The Engineering and Mining Journal. The official statement of the American Iron and Steel Association gives the total output at 7,586,354 tons, showing a reduction from our estimate of less than 0·5 per cent. This proves again how close an approximation to the actual production we have been able to secure in our preliminary statements.

The total production in 1898 was 6,609,017 tons, so that there was last year a gain of 977,337 tons, or 14·8 per cent. The make of Bessemer steel for 1899 was more than double that of 1894, and was greater than our entire production of pig iron only a few years ago. Of the total there were 3,968,775 tons, or 52·3 per cent., made in Pennsylvania; 1,679,237 tons, or 22·1 per cent., in Ohio; 1,211,246 tons, or 16 per cent., in Illinois; leaving only 727,092 tons, or 9·6 per cent., made in other States.

The largest single item of manufacture from Bessemer steel is rails, although the proportion used for that purpose has decreased largely. The increased output of steel is used for bars, plates, structural shapes, and similar forms. The consumption of the rail mills last

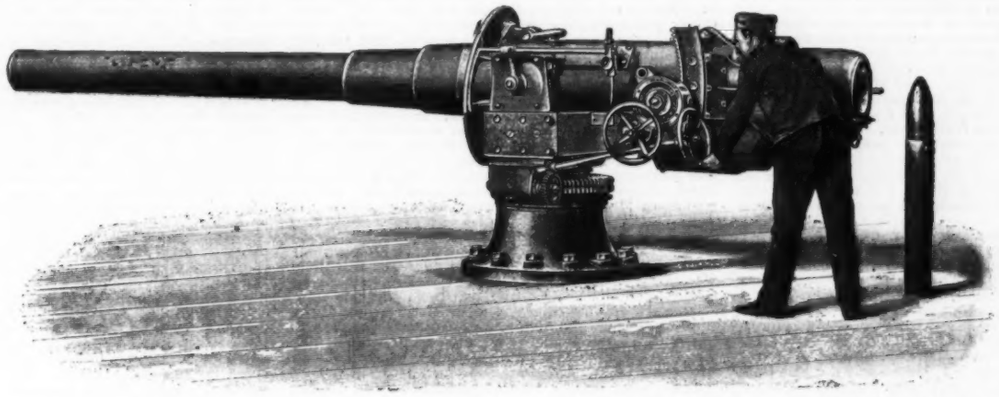
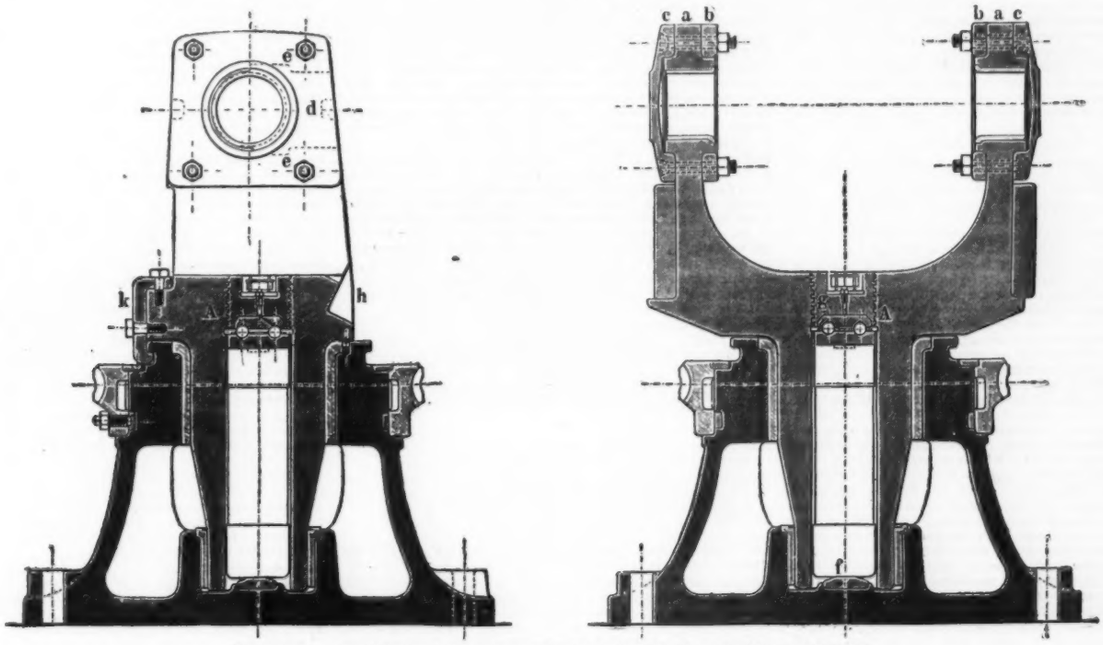


FIG. 3.—TRAINING A KRUPP GUN MOUNTED ON A CENTRAL-PIVOT SPRING-RETURN CARRIAGE.



FIGS. 4 AND 5.—TRANSVERSE SECTIONS OF SPRING-RETURN MOUNT.

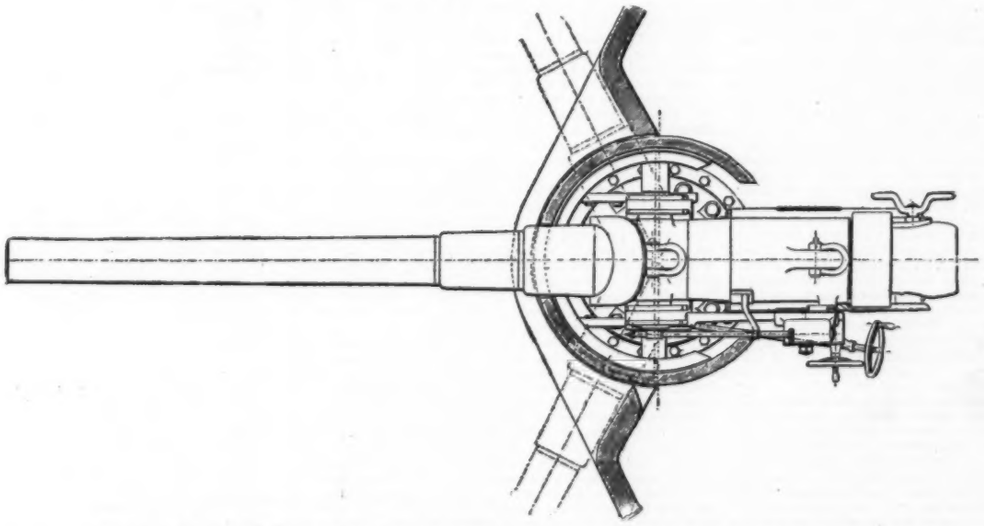


FIG. 6.—PLAN VIEW OF KRUPP 15-C.M. GUN (SPRING-RETURN MOUNT) IN BATTERY.

year was a little under 30 per cent. of the total steel made. There were 2,240,767 tons of steel rails made from Bessemer steel in 1899, an increase of 285,340 tons, or 14·6 per cent. over 1898. The quantity made from open-hearth steel and from old rails re-rolled will bring the total production of rails in 1899 up to 2,300,000 tons. The largest output reported in any preceding year was 2,044,819 tons, in 1887.

For three years past the American Association reports have classified the rail output by weight of sections, and the comparison is an interesting one, as showing the increasing tendency to the use of heavy rails on our railroads. Last year there were 130,135 tons, or 5·8 per cent. of the total, of 45 pounds to the yard or under: 1,531,108 tons, or 68·3 per cent., between 45 and 85 pounds; while 579,524 tons, or 25·9 per cent., over 85 pounds. A considerable part of the latter were of sections as high as 100 pounds to the yard. That over a quarter of the rails made should be of these very heavy sections shows the growth of our railroad traffic and the consequent use of heavy rolling stock.

Nearly all the Bessemer steel made in the United States continues to be made by the acid process, the proportion of basic Bessemer being very small. This will doubtless continue to be the case as long as we have at our command such a large supply of ores comparatively low in phosphorus. There has been much complaint in recent years, which is growing rapidly under the high pressure demand for rails, of the increasing percentage of phosphorus in rails now manufactured—indeed so large is this that many of our rails are far too brittle to be quite safe, and an increasing number of "accidents" from this cause may be expected. The scarcity of ores and the cheapness of the Bessemer process have induced the steel makers to use, in Bessemer steel, phosphorus material that should not be passed. The consequence will certainly be to throw much discredit on our rails, and this at a time when we are building up a large foreign market for them, is a very serious matter.

The more general adoption of the basic and open-hearth processes will certainly come as the low phosphorus ores become scarcer, and it is to be hoped that this change will come promptly and before serious injury is done.

IS THE STEERING OF THE MODERN SCREW-PROPELLED VESSEL DEFECTIVE?

By the late CAPTAIN CORNELIUS W. MCKAY.

FORTY-TWO per cent. of steamship disasters have been caused by strandings alone, during the year 1898. The statistics lately published by British Lloyds Register of Shipping affirm this fact. It seems to be an old story among shipowners and marine underwriters—this large ratio of losses due to strandings, as compared with that due to other causes—such as collisions, founderings, abandonment at sea, and "missing ships." Ships founder by reason of inherent weakness consequent to structural defects and the deterioration of age. They are stranded not only by the insuperable conditions of stormy weather and thick fogs that attend their navigation, but also by errors made in the calculations of the masters, pilots, and officers, errors perhaps that are due in a great measure to human fallibility. According to British records during the year ending June 30, 1897, nearly two thousand steamships stranded on the coasts of Great Britain. Twenty-one steamships foundered at sea in the same time. Needless to say here, perhaps, that such an immense disparity in the size of these two shipwreck producing factors—factors, too, that are "constant" in the problem of safe navigation—has excited more or less comment throughout the maritime world. School boys know that the coasts of Great Britain have been surveyed and mapped out to the last degree of hydrographic art and skill, making the road to the mariner like an open book, as it were; and yet, in this age of steam, that has furnished a propelling power intrinsic to the ship herself, the ratio of casualties by stranding to that of other causes has been increasing every year. In view of the indubitable fact that nothing is more dreaded by the mariner than running his vessel ashore, what can reasonably be inferred from the statistics?

Naturally the question arises—does "familiarity breed contempt" in steamship navigators, or are they ignorant concerning the limits of the modern steamship's capability? In other words, what knowledge has the nautical and naval world in general—and the merchant marine in particular—about the philosophy which governs the control of a twin-screw ship? Since 1868, the European naval powers have been investigating experimentally the steering properties of their screw-propelled warships, but investigating them with the single view of determining the ship's efficiency for "tactical purposes—that is to say—the ship's inherent turning powers." The actual path that is described by a ship's center of gravity, in response to her helm, when she is in motion, was never observed definitely until experiments were made with the British warship "Thunderer" in 1877. Previous to this, however, (1862) Commander T. H. Symonds, R. N., had declared before the Society of Arts, London, that "No steamer of great length could be moved with certainty or anything like it"; and the steamship of to-day is nearly twice as long as she was then.

Some experiments have been made under the auspices of the British Association (1875-7) with screw-propelled vessels to ascertain the law governing the action of the ship's rudder when the screws were reversed. Nautical England then was in a fever, which extended even to the Admiralty Court, concerning the aberrant steering of the screw-propelling ships that had been observed in cases of collision. "It was a question," said Prof. Osborne Reynolds in his report to the British Association, "of secondary importance only to the correct adjustment of the ship's compass." No doubt but a steamship's steering properties are better understood to-day than they were at that time; and yet, about some peculiarities concomitant to a screw-propelling ship's behavior, experienced shipmasters still disagree. The hard fact is, however, that each ship is a problem in itself. Navigators should know their ships beyond all doubt; but it may well be queried, in view of the rapid engineering progress of the age, what chance have they had to learn? The mechanic, ship-builder, naval architect, engineer, electrician, metallurgist, hydrographer, and even the naval officer have kept step in the march of improvement; but the navigator; what has been his progress in the art and theory of safe navigation during the last twenty years? He is reminded often, after risking (perhaps losing) his life on the sea, by the callow critics on the shore, of that old-time proverbial alliteration, "Lead, Latitude, and Look-out"; and really, it does appear as if, in obedience to powers over which he has no control, the modern steamship navigator, in some situations, "goes it blind."

Viewed as a projectile, or a vehicle, or a motor machine, the modern stern screw-propelling ship is certainly an awkward unwieldy affair. This much should be patent even to a kindergarten student in the mechanics of moving bodies. The "rudder experiments" made with the United States steamer "Monterey" as late as February, 1895, demonstrated very pertinently the twin-screw ship's extreme unwieldiness. The report made of this ship's behavior was read before the Society of Naval Architects and Marine Engineers in New York on November 7 and 8, 1895. It says:

"It was impossible to get any reliable observations with a helm angle less than fifteen degrees. The helm was rarely amidships when the vessel was steering a straight course. . . . So much helm was carried to steer a straight course that the arc of the swing of the rudder was lessened . . . as to render the recording . . . the maneuvering angle of no value. The wind, weather, etc., . . . during the trials was all that could be desired."

These experiments were instituted by the United States Navy Department to ascertain the amount of twisting strain on the vessel's rudder-head when the rudder is in action. The "Monterey" is 256 feet long and, comparatively speaking, she is a wide and shoal modeled warship, which peculiarity of form no doubt tends to exaggerate the defects inherent in the system of stern screw wheel propulsion. But there they are. It took from 10 to 15 degrees of helm to "steer her straight." How much less of helm angle does it take to steer an Atlantic "record breaker" straight and where, in naval literature, can any testimony whatever relative to this query be found? And, moreover, can a ship's path be straight—that is to say—in a line with her keel when her rudder is operating? In the view of the writer such a thing is a mechanical philosophical absurdity. What, then, can possibly be the amount, or a degree, of the ship's deviation that is due directly to the operation of her rudder, and where in the practical routine, or the technique, of steamship navigation is an indication of such deviation to be sought when, let us say, the ship, making a straight wake, is steering a course in thick weather across a current which is setting forward of her beam? In illustration of such a situation let the following diagram represent the longi-

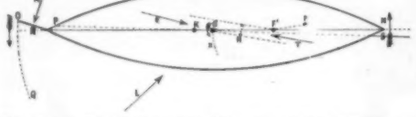


DIAGRAM SHOWING THE FORCES WHICH TEND TO THROW A MODERN SCREW-PROPELLED SHIP OFF HER COURSE.

tudinal-horizontal section of a ship that has been swung from the northeast to the north in order to meet a current setting on her port bow, and now held to her course by the action (leverage) of her rudder.

Let the line, *R S*, in the figure represent the ship's middle line, or the line of her keel, *A*, the rudder force acting at *R*. Obviously this rudder force is concentrated at *P*. It swings the ship's stern through an arc, *O Q*, whose radius is never less than the distance of the rudder from the ship's center of gravity, *G*. Simultaneously with the movement of the stern to the starboard the bow in reciprocation moves to the port, exerting a retarding lateral pressure, the instantaneous effect of which determines an axis, *F*, which in position locates itself at some point that is, of course, nearer to *S* than to the middle of the ship's length. Consequently, the initial impulse of the rudder acts as a lever of the second kind its instantaneous axis, and fulcrum, being (assumed) at the point, *F*. As the stern swings through the arc the point, *G*, the ship's center of gravity, moves to the starboard from the line of the ship's course. The distance that *G* (the whole ship) will move away from the intended course is very plainly proportional to the leverage exerted at *P*, a leverage which depends wholly upon the initial position of the fulcrum, *F*, relative to (the weight of the ship) the point, *G*. The distance between these two points, fulcrum and weight, is a variant, its value depending on several conditions: First, the angle, sharpness, or finenes of the bow; second, the area and configuration of the submerged lateral section forward of *G*; and third, the momentum of the ship.

Obviously if, when in motion, a centerboard were dropped at the bow near *N*, increasing thereby the area of submerged lateral section, the extra lateral pressure generated would retard the circular movement of the ship to port; and this extra degree of retardation would cause the resultant of the fluid resistance, (lateral) *F*, between *G* and *N* to move toward *N*. And again, as the ship's speed is increased, the augmented resistance generated, the (hypothetical) centerboard would also cause the point, *F*, to approach *G*. The point, *F*, at first a fulcrum, soon becomes a pivot on which the ship begins to revolve. Her angular velocity at first is small comparatively, but, as the bow turns to port, the head resistance of the water, *T*, exerts more or less of a lateral pressure toward the port and assists the pressure of the rudder. Meanwhile the initial fulcrum and pivoting point, *F* (always in a state of flux while the ship is revolving), is moving aft toward the middle of the ship, ultimately resting at *G*. The foregoing is a perfunctory attempt to illustrate (in direction only) the interdependent motions of the forces consequent to the action of the rudder that turn the ship through four points of the compass. One thing is obvious, and is to be noted, that the direction of travel of *G* is always forced from the rudder and also from the line of keel; that is to say, away from the ship's course. And again, that the longer the ship's bow relative to her stern, the nearer is the center of gravity, *G*, to the rudder, and, consequently, the further is it moved.

Everything else being equal, bodies turning in a fluid are resisted in the ratio of the fifth power of their length. The modern steamship is long, very long, and sharp at her ends, and proportionately she is also very shoal, which latter feature philosophically viewed, makes her still longer. Experiments that have been made, as well as the practice of merchant seamen, have proved that length being equal, the ship having the greater draught is the handier vessel. In fact, lengthening a ship makes her more awkward to steer, makes her want more room in which to turn (or more speed or helm power to turn in the same room) than does a shorter ship. The modern steamship is from 30 to 50 per cent. longer than the ships of twenty years ago, and, gainsay it who may, she is more awkward to handle and cannot be steered so "fine" as the older ships. This practical difficulty has been increasing in a geometrical ratio with the rapid strides lately made in the practice of marine engineering. Proportional to the ship's total displacement the propelling power too has been growing larger every year. Economy of the ship's internal space has demanded also that her engines, boilers, and coal be more concentrated, and placed further aft. But the ship must trim properly, and any variation in either the trim or the draught of these large ships is limited. They must be adapted to the navigable depth of waters in which they sail. Consequently, to meet this change in the situation of her weights in modern design, the ship's center of buoyancy has pari passu been shifted so that a good trim may be preserved. Now, the longitudinal position of the center of buoyancy determines the length of a ship's bow; and moving it aft, of course, makes her bow proportionately longer. Hence in the modern steamship that long, sharp bow, which is so fascinating to young and ambitious naval architects, and far abaft the middle of the ship's length as the center of buoyancy may be the modern steamship's longitudinal center of gyration, is still further aft, all which diminishes the ship's helm power.

Let the figure represent the longitudinal horizontal section of a modern screw-propelled ship—a "record breaker"—six hundred feet long and steaming twenty knots an hour. To counteract some extraneous force (arrow point *V*) on her port bow, and to make her course good she has starboarded her helm. Very obviously this force, *V*, whatever may be its nature, will operate to turn the ship's bow to starboard—the ship rotating round a perpendicular axis through her center of horizontal longitudinal gyration at *K*. The ship's vertical motions too—pitching and 'scending, round an athwart, ship horizontal axis through her center of gravity (so far aft) and her rolling and righting motions round a longitudinal horizontal axis, are motions all caused by the action of gravitation but which tend, nevertheless, in connection with *V*, to force her bow to the starboard away from her course, so far aft is the pivoting point of the ship's support. Let these motions be ever so small, as, perhaps when she may be running against a ground swell, her momentum, as she moves twenty knots an hour, when combined with the energy propagated by a ground swell, running in the direction of the arrow point, *V*, will augment their effect. But, of course, this tangential, or oblique force whatever may be its nature, or its rotating effect upon the long bow, can be, and is, counteracted by the leverage of the rudder, as the ship is steered by compass steadily on her intended course.

In consequence of the force acting at *P*, the ship's stern has been swung to the starboard, we will assume; and, in a degree that has been determined by the position of the fulcrum and axis, *F*, the bow has been swung, contra clock-wise, to the port. This lateral "wheel and axle" motion has ceased, and the ship's motion has become more rectilinear as the turning force exerted by *V*, is checked by the forward progressive movement of the ship, (her momentum) combined with the force of her head resistance, the resultant of which, in the meantime, has been diverted by the action of the rudder from the line of keel, and in the direction of *T*. The propelling power acting constantly through the center of gravity, (a fixed point) against the resistance on the bow of the water acting through *F* (a variable) is the situation as represented in the figure. Obviously as the ship moves in the direction of *T*, she is in a state of forced equilibrium. She is sailing her course through the water but is under the constraint of a "mechanical couple" of which *H* is the arm. The force (leverage) that keeps her steady—that also determines the angle made by *T*—(with her line of keel) is that which is exerted at *P*, by the rudder. Now, the power of the rudder (other things being equal) varies with the angle which it makes with the keel. Consequently, the "rudder-angle" is always equal (in effect) to the angle made by *T*, at the bow, or what is the same thing, the course which the ship "makes good." In other words the turning effect of the rudder, equal in amount to the constraint exercised by the turning couple amidships (whose arm is *H*) is equal also to the force (leverage) that acts upon the ship's center of gravity. This constant leverage of the rudder may be likened to a lateral centrifugal force moving or tending to move the center of gravity *G*, from the line of keel, or what is the same thing in the kinematics of the ship, displacing the ship itself. As far (in distance) as the center of gravity, *G* is forced to the starboard, or conversely, as far as the ship is displaced to the port, by the force of the ship's rudder, will the path that she makes through the water vary from her line of keel, or in other words, be askew with her intended course. This deviation is always equal to an angle whose tangent is the distance that the point *G* is forced from the line of keel, and whose radius is equal to the distance between *G* and *F*. This angle corresponds to the angle of leeway made by sailing crafts when close hauled on a wind. Turning experiments made with warships in Europe have determined this angle to be somewhere between ten and sixteen degrees, when the ships were steaming at full speed with their rudders hard over and making a circular path through the water. What this angle would have been had these same warships been steering with a smaller angle of the rudder and over a

greater distance—making thus a path through the water less circular than they did—is still an enigma. This particular phase in a warship's movement (leeway) was a question of no moment to the men-of-war. Seawarriors don't fight in thick weather, nor do they steer by compass when they are fighting; and, in their navigation, national ships are seldom if ever compelled to "cut time." What the "drift angle" or the "tactical diameter" of a merchant steamship, whose every element is so unfavorable to her rotation would be, is beyond conjecture, as no experiments have been made with the "record breakers" that the writer knows of.

Current sailing in theory is simplicity itself. Since the days of Christopher Columbus navigators have been investigating their set and drift, and surely something must be known at this day about the currents that flow within a stone's throw of the European shores. Winds and waves are, of course, variable in their force; but the navigator cares little about them only so far as they may affect his own ship. He gages the potentiality of the elements he is contending with by the craft under his feet; and what can be his knowledge of the modern steamship—this late innovation, this combination of steam, steel and electricity? Only what has been gained by his experience in sailing such craft.

It is respectfully submitted to the nautical world that the modern twin-screw ship does not always sail as she is pointed; in fact, that she cannot. When subjected to a force acting obliquely on her bow, as at *V* in the figure, the leverage exerted thereby to turn her bow exceeds that of other vessels, and in a manifold ratio. Her longitudinal center of gyration being so far aft (say at *K*) generates this excess in the rotating effect of the wind and waves; and when counteracting this excessive turning leverage, that is consequent to her design, in a twin-screw ship the rudder must act against the turning force exerted by one screw—half the propulsive power of the ship. The rotating or deviating effect of a screw propeller on the twin-screw ship is proportional to the distance it is placed from the middle line of the ship, and it constantly operates against the turning leverage of the ship's rudder. In diminishing the (instantaneous) effect of the rudder the deviating force of the screw propeller is also reinforced by the twin-screw ship's comparatively great (athwartship) moment of inertia, which is owing to the weights of the engine, boilers, shafting and propelling wheels that are placed (spread apart) on each side of the keel. The property of good steering depends directly upon the instantaneous effect produced by the rudder. Hence, in the twin-screw ships, the large "balance" rudder actuated by a special engine; and powerful as it may be it is still weak, comparatively, when turning the ship, for it must counteract first the deviating leverage of one propelling wheel; second, the greater (comparative) inertia of the ship, and third, the great (comparative) angular resistance of the water that is due to the length of these ships. This three-fold resistance to the action of the rudder is, of course, finally overcome. But how? By a "shunting" of the ship's momentum away from the line of the thrust of the screws. The rudder effects this, and its constant deflecting pressure forces, as the "wind jammers" would say, "down to leeward" the ship's center of gravity, from which position the true path of the ship originates, it being, in fact, the apex of the angle of deviation of that path from the line of keel. The modern steamship has no concentration of submerged lateral area about her center of gravity (like a "cup defender") to support this immense deflecting pressure of the rudder. In comparison to other vessels she floats upon the surface of the water like a bamboo pole, the difficulty in guiding nicely when it is moving swiftly through the water endwise by a force exerted on its rear end, is sufficiently obvious. "But surely," may query some sceptic, "while the ship is steady in her motion and steering by her compass, this variation, this acute small angle of deviation, cannot be large, or it would be noticed." The reply is that it has been noticed. The steering property of every new British warship is investigated experimentally, and the results at all practical speeds and rudder angles are recorded for the use of her officers. Under certain conditions and within certain limits a stern screw-propelled ship is as likely to sail askew to the line of her keel as she is to sail in its direction; and these excessively long ships, when sailing under conditions similar to those illustrated in figure, must always vary more or less in the path that they make from their line of keel. If a "record breaker" should vary in her course only one degree (which certainly is not much) it would matter little, perhaps, in the navigation of the Atlantic Ocean. This fact is beyond all controversy. But one degree, more or less, might mean something when dusting the whitewash off the lighthouses on the shores of the English channel to "cut time," as some navigators on the Atlantic ferry are compelled to do.

(To be continued.)

ON MOUNTING PRINTS WITHOUT COCKLING.

ONE of the serious incidental troubles which beset photographers is the difficulty encountered in mounting prints upon paper or thin card without causing unsightly puckering of the margins, which the photographer calls by the not very euphonious but expressive term cockling. So very truly remarks the editor of our excellent contemporary, The American Journal of Photography, from whom we quote this article.

He is often required to mount the print upon plate paper, which is bound up in book form, and the slightest creeping of the edges coming in contact with the paper is sufficient to condemn the work as a bad job. Some photographers use rubber solution (ordinary India rubber dissolved in chloroform or benzole), which is a very effectual remedy for a time, but sooner or later the print will leave the mount. Those who have a desire to get permanent adhesion try to mount the prints with some material which has the least amount of water in its make up; for it is the water in the mountant which causes the trouble.

A print treated with the ordinary starch paste, in which water is an ingredient, absorbs moisture, and so swells and stretches. If in this condition it is attached to some yielding material like thin card or paper, as the water evaporates the paper shrinks out of shape, and when it is dry the print appears crimped about the edge, and uneven all over.

Glue or gelatine dissolved in acetic acid, which would meet all the requirements of a perfect sticker, cannot be used in mounting photographic prints, for the obvious reason of the injurious action of the acid on the silver. More than thirty years ago Wharton Simpson advocated a plan of mounting with gelatine or glue without the agency of water or acid as a solvent. It was really a solution of gelatine or glue in alcohol.

At first sight the operation of dissolving gelatine in alcohol seems an impossibility to those who know that gelatine is always precipitated from aqueous solutions by alcohol. However, its solution may be effected in a roundabout way.

Take half an ounce of gelatine, cover it with water, and allow it to swell for twenty-four hours. Pour off all the water except two or three drams, place the gelatine with this trace of water in an ordinary glue-pot on the fire, surrounding the pot with water. When it is melted have ready six ounces of alcohol, and add it a little at a time, stirring steadily with a glass rod, and maintaining a moderately high temperature. By proceeding carefully in this way perfect mixture is secured, and the solution is then poured off into a wide-mouth bottle or jar corked or stopped for use. It is well to rub the stopper previous to insertion with a little paraffin to prevent adhesion to the neck of the bottle.

Mountant so prepared needs no preservative. When cool the solution sets, but by placing the bottle in hot water or near the fire it becomes fluid again. Prints mounted with this paste show no signs of cockling, because the evaporation of the solvent is rapid. Indeed, the mounting must be done quickly to prevent setting, and the exact position the print is to occupy must be determined before placing it down on the mount, as when once it has been laid down upon the card in the place it is to occupy it cannot be shifted.

The addition of glycerine has been recommended, but its hygroscopic properties do not recommend its use, though doubtless it would retard the setting of the gelatine. Those of us who use glycerine in the final washing of celluloid films know how difficult it is to get rid of the moisture upon the surface of the film.

We have used this mountant of Mr. Simpson's, remarks the editor of The American Journal, for a number of years, and have found it most satisfactory. The prints are as firmly attached to the paper as they were the day they were first mounted, and lie perfectly flat and smooth.

For ordinary mounting purposes on card we have found a paste made from starch excellent. The starch is first mixed to a cream with the whey of milk (obtained by precipitating the curds by means of hydrochloric acid, and then completely neutralising any trace of acid with carbonate of soda). The creamy mass, which should be free of lumps, is now treated to boiling water until the starch gelatinises, stirring briskly all the time. A few drops of alcoholic solution of thymol will preserve this mountant indefinitely. The small amount of soluble casein in the whey adds materially to the sticking qualities of this adhesive.

PORCELAIN AND WATCH DIAL PICTURES.

THIS is, in our opinion, one of the most beautiful branches of photography, and it rather seems strange to us that photographers generally are so backward about pushing these porcelain pictures before the public. As a usual thing they bring very handsome prices, and at but little outlay. While it is true that there are several processes for making this work that have been before the photographic fraternity for years, yet it is surprising how few of the craft are acquainted with any of them. In this paper we will give our favorite way of making these pictures. We also use the same formula for printing on watch dials, and find it even more satisfactory than carbon. The advantage we have in this formula and manner of working the porcelain, is that we can get any tone we may wish, from the very warmest sepia to the dead black and white tone, or even to the blue-black. Thus we see that we have as great a control over our colors as we would have in the carbon. We have always preferred the porcelain plate, 6½ by 4¾ in size, for the reason that in this size they are more convenient to handle, and further, as a usual thing, photographers use a 6½ by 4¾ plate for making cabinet photographs. For this reason it is easier to make a contact print on a 6½ by 4¾ porcelain, as we can lay the negative in the printing frame, and the porcelain frame directly on top of it, as in printing on paper.

These plates can be secured from any good stock dealer at a nominal cost. We must be very careful about cleaning them. They must be entirely free from any dust or grease marks such as the fingers will leave on them if they are touched. They come with one side a matt surface, the other having a high polish or gloss. Either side may be used, and it is a good idea to have samples of both gloss and matt surface to show your patrons.

To clean the plate I would take bicarbonate of soda, and make a paste of it by the addition of water, and thoroughly scour the plate with this, after which take two ounces of water and one drachm of nitric acid, and with a tuft of cotton go over the plate, afterward polishing it with a chamois skin. After your plate is perfectly clean and free from dust, it should be flowed with albumen made of the white of one egg and water two ounces. This should be put in a bottle and small pieces of glass dropped in the bottle; then the solution should be shaken for several minutes; the pieces of glass serve to cut up the egg and cause it to mix with the water more thoroughly. Without using something for cutting up the egg, it is almost an impossibility to get it to dissolve in water. After your plate is cleaned, dip in a basin of clear water, and then flow with this albumen. The plate can be more evenly flowed while wet than is possible after dry. Flow the albumen over once, and allow it run into the sink. Flow a second time, allowing that to run back into the bottle. The reason you flow the plate twice is, the first time you flow there is more or less water on the plate, and the albumen has not the chance to "take;" whereas, when it is flowed the second time, the water has been repelled by the first flowing, and thus the second flowing takes to the plate.

Of course, the reason why you allow the first flowing to run into the sink is because it has taken up the water from the plate and is weakened. The second flowing is just as strong as at first, and can be saved and used over and over. After flowing with the albumen, the plate should be dried. For this purpose I would suggest that you have a "drying-box" in which you can have a small lamp. The advantage of drying by heat over spontaneous drying is that you can put your plates away in an air-tight, and therefore a dust-tight box, thus keeping the plates free from particles of dust. Of course, there should be a flue for the heat of the lamp to pass off, but this will not admit any dust while in use. After the plate has dried, it should be flowed with the following emulsion:

STOCK SOLUTION, NO. 1.

Alcohol	3½ ounces.
Ether	4 "
Gun cotton	60 grains.

STOCK SOLUTION, NO. 2.

Nitrate silver	60 grains.
Distilled water	½ drachm.

STOCK SOLUTION, NO. 3.

Chloride calcium	16 grains.
Alcohol	2 drachms.

STOCK SOLUTION, NO. 4.

Citric acid	16 grains.
Alcohol	2 drachms.

All of these stock solutions should be added together, but it must be done gradually, or in this way: Add number two to number one in about four additions, shaking well after each addition. Then add number three in the same manner, and last add number four in same way. After this has been flowed over the plate and allowed to dry in the same way as you dried the plate after albumenizing it, we are ready for printing. This is done in the same way as for printing on any of the printing-out papers.

The most pleasing effects can be obtained, however, by using a border around the porcelain. This can be done by taking a piece of opaque paper (that which comes wrapped around your dry plate is an excellent article), 6½ by 4¾ inches in size, and cutting an opening in the center, say about 3 by 5 inches. This will, when placed on your negative, between the porcelain plate and the negative, give you a white border around the porcelain of one inch. Not being able to bend the porcelain plate, it will, of course, be impossible to examine the print while printing. To overcome this trouble, I always use a "dummy" negative; by this I mean a negative of as near the same depth and color as the one I am printing from. On this "dummy" negative I place a piece of ordinary printing-out paper; when this paper is dark enough, I consider my porcelain dark enough. You must be sure to put the negative from which you are making the porcelain and the dummy out at the same time, and be careful to have them facing the sun at the same angle. In the majority of studios it is customary to make at least two sittings of every customer; the discarded negative in both cases will give you the correct dummy.

Now it must be remembered that these pictures can be toned in either sepia or black and white. If we are going to make sepia tones of them, they should not be printed so dark as for black and white or platinum tones. Print for sepia tones to about the same depth you would for any glossy paper that was only to be toned in a gold bath.

For platinum tones you should print to a very deep tint; print until the high lights begin to tint. After printing, the plate should be washed thoroughly in about five changes of water if washed by hand, or for about five minutes if washed under the tap. After washing, they should be toned in the following gold bath to whatever tint of sepia you want. In all cases, however, the high lights should be cleared up:

GOLD BATH.

Water (distilled or ice water)	40 ounces.
Gold	½ grain.
Salt	½ teaspoonful.

To this add, of a saturated solution of borax enough to turn the bath alkali in about four minutes. Test your bath with litmus paper; don't try to guess at it; neither you nor any one else can guess at mixing your formulæ. After the gold toning, the plates should be given about three minutes' washing under the tap, and then if you want a platinum tone or black and white effect, they should be toned in the following platinum bath:

STOCK SOLUTION OF PLATINUM.

E. A. platinite	15 grains.
Phosphoric acid (50 per cent. sol.)	2½ drachms.
Water	2 ounces.

PLATINUM TONING BATH.

Water	40 ounces.
Platinum (stock solution)	2 drachms.

Plates should be toned in this until every particle of red has disappeared from the shadows. In testing for red in the shadows, it should be done by looking through the plate, holding it between you and a strong light. If there be any red in them you will easily see it in this way.

After the platinum toning, wash them again for about three minutes, and then into the fixing bath. The fixing bath should test 25° hydrometer test. Don't guess at the strength of your hypo bath. It may be too strong and bleach your prints, or it may be too weak and not fix them. Get a hydrometer; it will cost you about fifty cents, and then you are certain to get it right. The plates should remain in the hypo for about fifteen minutes, not longer; sometimes a little less will save bleaching. After fixing, they should wash in running water for at least one hour, or about sixteen changes by hand of five minutes' duration between the changes.

The neatest way we have seen for delivering these pictures is in narrow gilt frames. The molding for these frames should not be over half an inch wide; the frame should have some little ornament at each corner. You can easily get what you want by looking at some frame manufacturer's catalogue. Bear in mind, you can put pictures on watch dials in the same way as given for porcelain. I have placed as many as four

different heads on one dial. The same formula is also especially good for printing on silk, satin, or linen, with the exception that you do not use the albumen for any work on fabric. With this exception, the work is exactly the same.

Any of you that are capable of using water colors, pastel or oil, will find here a chance to display your abilities. Some of the most beautiful pictures we ever had the pleasure of seeing, were made on porcelain and colored in pastel. I am sure that if some of you will try this work and make a run on it, you will easily pay the expenses of your studio. But don't make them for glory or fun. Charge for your knowledge, and the more you know the more you will charge.—Felix Raymer, in The Professional Photographer.

THE NATURE OF THE ELEMENTS.

By Dr. Curt Schmidt.

Up to the present time chemists have succeeded in discovering over seventy elements or simple substances. "These elements," Sir William Crookes has aptly remarked, "perplex us in our researches, baffle us in our speculations, and haunt us in our very dreams. They stretch like an unknown sea before us, mocking, mistifying, and murmuring strange revelations and possibilities."

At the beginning of the century Prout advanced the theory that there was but one primeval substance. The philosophers of Asia held this primeval matter to be the "blue ether." Thales thought it was water. Prout believed it to be hydrogen. If, according to these hypotheses, all elements be composed of hydrogen, it follows that their atomic weights must be multiples of that of hydrogen. Accurate measurements, which could not be made in Prout's day, prove that the atomic weights of many elements cannot be expressed in whole numbers. The atomic weight of chlorine is 35·37 times greater than that of hydrogen. The supposition that an atom of chlorine is composed of 35 whole atoms and 27 hundredth atoms of hydrogen is absurd, because it does not conform with the conception of an atom. Despite these failures, the hypothesis has not yet been abandoned by many prominent investigators. Lothar Meyer, for example, holds that the atomic weights of the elements are not exact multiples of the atomic weight of hydrogen, because they contain larger or smaller quantities of light-ether (*Lichtather*), which is perhaps not altogether without weight. It is of no moment whether the ether be chemically combined with the atom, or, as Naegeli imagined, whether it surround the constituents of the atom in envelops of varying density; for it would always form atomic weights which are not whole multiples of the primeval atom. This possibility may be proven experimentally. For if the ponderable ether enter the composition of a molecule, it might happen that the two bodies, after having been carefully weighed before and after their chemical combination, might have a total atomic weight not exactly equal to sum of the two original atomic weights, because, it was said, a certain amount of ponderable ether might have been either added or lost. In 1893, H. Landolt made a series of experiments which consisted in accurately weighing certain substances before and after their mutual reaction in sealed glass tubes. The experiments proved that in none of the reactions was a change in weight noticeable, thus disproving the theory that there was a loss or gain of ponderable ether in the combination of the two elements.

But the existence of a substance which forms a constituent of all elements in common is supported by the well-known periodical system formulated by the Russian chemist, Demetrius Mendeljeff. Nowadays Mendeljeff's grand truth is to be found explained in every elementary text book and even the merest tyro in chemistry knows that the properties of the elements are periodical functions of their atomic weights. The chaos of the seventy odd numbers representing atomic weights has been reduced to a system in which every element has its place. The composition of the chemical elements proves that all must contain a common something; and for this reason chemists still endeavor to analyze elements.

To one who has been accustomed to regard the so-called elements as compounds, the idea of an analytic and even of a synthetic chemistry of elements—that old dream of the alchemist—does not seem too bold. For many years the famous Heidelberg chemist, Victor Meyer, subjected the vapors of volatile chemical elements to exceedingly high temperatures for the purpose of observing the changes which took place. The apparatus used by Victor Meyer for determining the density of these vapors is represented in Fig. 1, reproduced from Der Stein der Weisen. *A* is a receptacle, made of glass, porcelain, or platinum, depending upon the temperature, which receptacle is suspended in the vapor of the heating liquid, *a*. At high temperatures a bath of lead is used; at very high temperatures a gas furnace is employed. When the temperature has reached the point desired and is permanently maintained at that point, the body (the vapor density of which is to be determined) supported by the stopper, *B*, is allowed to drop to the asbestos-covered bottom of the receptacle, *A*. The volume of vapor arising displaces a like volume of air or nitrogen, which passes through the branch tube, *b*, bubbles out at *f*, through the water contained in the reservoir, *g*, and through the water in the graduated glass, whereby its volume is measured. With furnaces of improved construction Meyer succeeded in obtaining temperatures as high as 1,700° C.

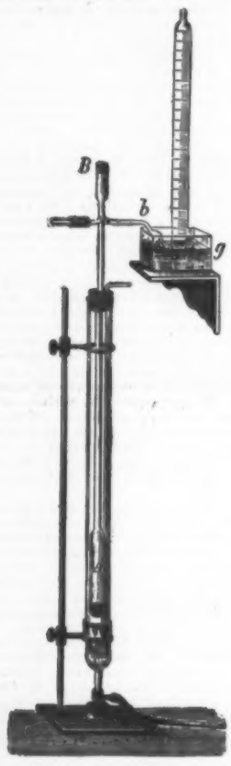


Fig. 1.—VICTOR MEYER'S APPARATUS FOR DETERMINING THE DENSITY OF VAPORS.

These pyrochemical experiments prove that oxygen, nitrogen, sulphur, mercury, zinc, and the other elements are unchanged even at high temperatures. The behavior of iodine, however, is most astonishing. As the temperature rises, the vapor density of iodine diminishes until at 1,400° C. it falls to one-half its original value. This phenomenon, it is true, does not prove a separation of the elements into its constituents, but merely that an atomistic division of the iodine molecules has taken place; for it has long been known that the iodine molecule is composed of two atoms.

Intense as the heat of 1,700° C. may appear, it is nothing compared with the fierce heat obtained by improved types and special apparatus. Meyer succeded in building a laboratory furnace, by which he was enabled to produce temperatures hitherto unobtained. In the fierce white heat of this furnace platinum and a 30 per cent. alloy of platinum and iridium were immediately melted; porcelain and firebrick used as a lining collected in a pool within the furnace. He was now no longer concerned with increasing the temperature but with providing vessels capable of withstanding a heat of 3,000° C. so that proper observations could be made. Even during the last years of his life, Victor Meyer was still engaged in seeking a suitable refractory receptacle. He discovered iodonium (a compound of iodine, phenyl, and hydroxyl) which in its behavior so strongly resembles thallium, a metal spectroscopically discovered by Crookes, that he termed iodonium a "composite thallium." But the brilliant Heidelberg chemist never reached the goal toward which he was striving.

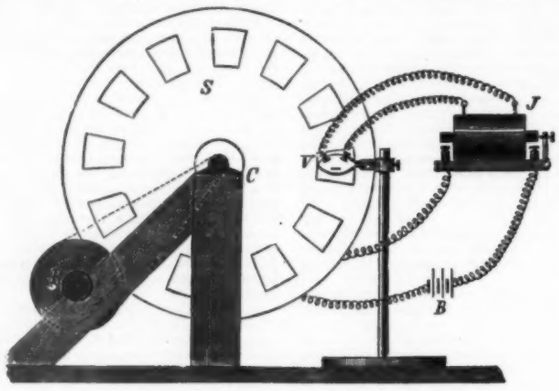


Fig. 2.—CROOKES' PHOSPHOROSCOPE.

Fig. 3.—SPECTRUM OF YTTRIUM.

Fig. 4.—SPECTRA OF FIVE CONSTITUENTS OF YTTRIA.

Fig. 5.—THE POSITION OF THE ELEMENTS ACCORDING TO CROOKES' SCHEME.

His death robbed the scientific world of one of its most brilliant investigators.

Nothing is more promising for the decomposition of the elements than the discovery of a new method of investigation. Such a method has been devised by one of the most noted living chemists and physicists, Sir William Crookes, in his "radiant matter test." For years Crookes has studied the phenomena exhibited by various substances in high-vacuum tubes, under the influence of the cathode discharge. He has termed this discharge "radiant matter" and has observed that, under its action, many bodies become phosphorescent to a greater or lesser degree. Besides the phenomenon of phosphorescence many bodies have the property of recalescence after the electric current has been interrupted. In order to fix the duration of this recalescence or residual glow, Crookes invented an instrument (Fig. 2) somewhat similar to Becquerel's phosphoroscope, but operated by electricity and not by light. The phosphoroscope consists of an opaque disk, *S*, formed with six openings concentrically arranged with respect to the periphery. The disk is rapidly rotated by the driving wheel, *R*, through the medium of a belt. For each rotation, a body placed behind one of the openings will be alternately visible and invisible six times. A commutator, *C*, forming part of the disk-shaft, alternately makes and breaks the circuit. The primary current is led to an induction coil, the secondary current of which is passed into the vacuum tube containing the body to be studied. When a phosphorescent substance is examined no light is seen when the disk is slowly rotated, because a current is not produced until the tubes have passed behind a segment, and is interrupted before the body appears. If, on the other hand, the disk be so rapidly rotated that the recalescence survives in the field of vision the short interval between the cessation of the spark and the appearance of the phosphorescent body, a feeble light will glow in the wheel, brightening as the speed of rotation increases.

The spectroscopic examination of this radiant fluorescence showed with most bodies a weak, continuous spectrum. Sometimes lines were also seen and among these Crookes observed a citron-colored stripe which presented the appearance sometimes of a sharp line, sometimes of a broad, nebulous band, but always having the same characteristic appearance and constantly appearing in the same position. For three years Crookes tried to trace the mysterious stripe to its source, entering that labyrinth of undetermined elements found in the rare mineral, samarskite. He finally proved that the mysterious citron-stripe was the characteristic line of yttrium. The nicety of the method enabled Crookes to prove the presence of yttrium in certain rose-colored corals, in tobacco ashes, in the bones of oxen, and in the meteoric stone of Alfianello.

What is yttrium? It is a metallic element present in several exceedingly rare minerals, such as gadolinite, yttrotantalite, etc. Its atomic weight is 88·9. Its phosphorescence spectrum consists of one dark red, one red, one brilliant, citron-colored line, two greenish-blue bands, and one blue band (Fig. 3). Crookes calls attention to the fact that most elements differ essentially in their properties, so that it is an easy matter to distinguish one from the other and to unite one with another. But the properties of certain other elements on the contrary, the so-called rare earths (among which yttrium is included), are so much alike that it is one of the most difficult tasks in modern chemistry to distinguish one from another of the same group. Mixtures of such earths or of the metals they contain appear to be homogeneous bodies or elements. If a comparatively simple body such as yttrium can be resolved into its constituents, who can say that it will be impossible to prove that other exceedingly simple bodies

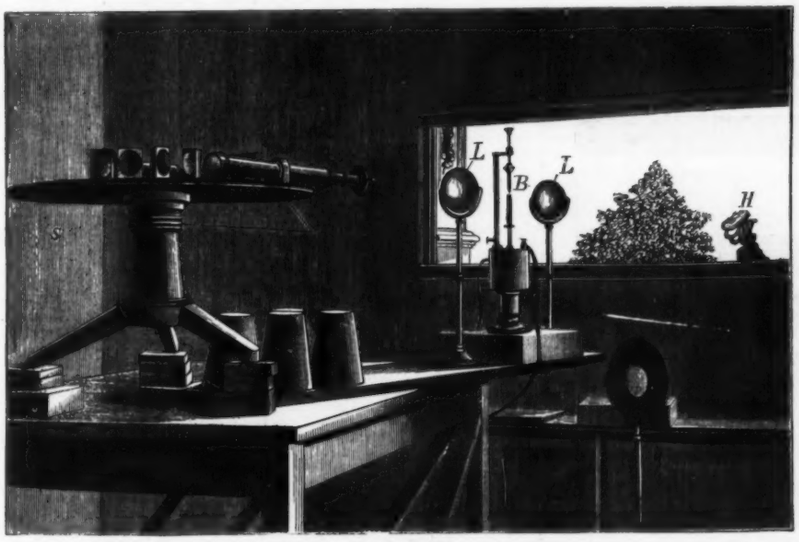


FIG. 6.—LOCKYER'S SPECTROSCOPIC METHOD.

are but the compounds of elements, whose properties are so strikingly similar that we have not been able with the inadequate means at our disposal to recognize the slight difference which actually exists? The study of the rare earths might possibly lead the way to the resolution of other compounds into their respective elements, compounds which have been hitherto regarded as simple bodies.

In order to separate the rare earths those chemical properties must first be determined which least resemble one another. If the earths differ, for example, in basicity, then ammonia is used to precipitate first the earths of small basicity and then those of greater basicity. The percipitate formed by the addition of a very small amount of ammonia is filtered off; the residue is dissolved in acid and reprecipitated by a very small amount of ammonia. This new precipitate is treated like the first, and thus the operation is repeated until a pure precipitate is obtained consisting of the earth having the lowest basicity. This process, called fractional precipitation or fractionation, is continued with the filtrates, until the last filtrate consists of water containing ammonia salt, and the last precipitate the earth with the greatest basicity.

By a careful fractionation continued for months, Crookes succeeded in obtaining five different fractions

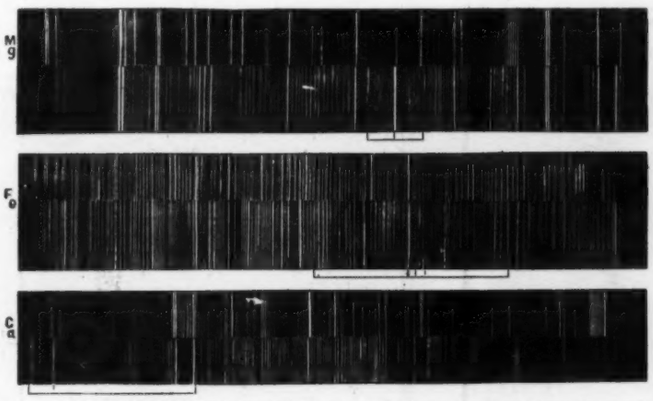


FIG. 7.—LOCKYER'S PHOTOGRAPHS OF THE ARC AND SPARK SPECTRA OF MAGNESIUM (Mg), IRON (Fe), AND CALCIUM (Ca).

of yttria (Fig. 4), each yielding a different spectrum, forming part of the spectrum hitherto considered as that of yttrium. Only the phosphorescent spectra of the fractions differ from one another; the ordinary spark spectrum is exactly similar to that of yttria. Crookes explains this remarkable circumstance by the hypothesis that the structure of an element is complex. Between the atoms as originally created and the atoms which we use in chemical reactions there is an intermediate class of "sub-molecules." These sub-molecules are distinguished from one another by the positions they assume in the structure of the molecules themselves. The distinguishing characteristics of these constituents, are their property of chemical fractionation and of molecular bombardment in the vacuum of a glass bulb in the intense heat of the electric spark these nice differences disappear and all fractions of the spectrum give the original substance.

Bodies which though neither compounds nor mixtures are not elements in the strictest sense of the word, have been termed "meta-elements" by Crookes. Yttrium, gadolinium, and didymium are examples of such meta-elements.

From the splitting up of yttrium a body which answers all the requirements of an element, but which by fractionation can be separated into groups of varying basicity, Crookes infers that his principle can be applied to all elements. What we have hitherto been pleased to call the molecules of elements, composed of like atoms, are in truth, compound molecules consisting of different atoms. What we have hitherto been accustomed to regard as the properties of an element, are only the resultants of very similar, but nevertheless unlike properties of the components. The elements, therefore, are not simple bodies.

But if the elements be compounds, the question naturally arises. What is the genesis of these elements? According to Crookes the elements were formed of a something previously existing when the universe was "without form and void." This primeval matter he conceives as a "fire-mist" or "protyle" in an ultragaseous state. Protyle was condensed by a process analogous to cooling; and matter, as we know it, was created. First the elements with small atomic weights were formed. Hence, hydrogen was, for a time, the only form of matter in existence. Then followed in the order of their atomic weights the other elements, uranium being, therefore, the last of all. If the condensation took place gradually, sharply characterized elements were created; because greater time was alloted to them for the development of their chemical individuality. A rapid, irregular condensation produced substances separated from one another by ill-defined lines of demarkation. Among bodies of the second class are iron, cobalt, nickel, the platinum metals, and, above all, the groups of rare earths.

Besides the cooling of protyle, another form of energy was active, which, having periodic cycles of ebb and swell, rest and activity, was intimately connected with the imponderable matter, essence, or source of energy we call electricity. Diagramatically the progressive cooling can be represented by a line gradually lengthening in a downward direction. The periodic force, were the temperature to remain constant, would be represented by a circle; but the temperature changed, for which reason the periodic force is represented by a spiral. Thus is expressed the repetition of creative conditions, which, though resembling, are not identical with previously existing conditions. This "atavism of the elements," as Crookes ingeniously terms it, is the cause of the formation of the natural families of the periodic system (Fig. 5).

At one time it was hoped that the spectroscope would throw light on the nature of the elements and reveal a common constituent in two or more elements, but these hopes grew vain, until the celebrated English physicist, Sir J. Norman Lockyer, stated, to the astonishment of science, that the study of solar and stellar physics showed that the elements were composite bodies. In the sun an opportunity was offered of studying the effect of a heat more intense than that of our hottest furnace, of motions compared with which our hurricanes are but gentle zephyrs. In his researches Lockyer employed a new and unique spectroscopic method. With a convex lens he projected an image of the electric arc or induction coil spark by which the metal to be studied was volatilized, upon the slit of a spectroscope (Fig. 6) and examined the various regions of the heated vapor. Photographs of such spectra showed, as previous investigators have found, that the lines of the metals were not of equal length (Fig. 7). By means of this method Lockyer demonstrated that if one of the constituents of an alloy be present in exceedingly small quantity, the spectrum of this constituent will show only the longest lines of the spectrum of the unmixed substance, and that, if the constituent in question be present in greater quantities, its other lines will gradually appear in the order of their length in the spectrum of the pure metal. Similar observations were made with chemical compounds. It was proven that lines of a certain substance vary not only in length and in number, but also in brilliancy and breadth, depending upon the quantity of the substance.

Furnished with these facts and determined to ascertain what elements are present in the sun, Lockyer decided to produce a solar spectrum 100·5 meters in length, by which he could compare photographically the Fraunhofer lines with the spectral lines of the metallic vapors in the voltaic arc (Fig. 8). Since it is impossible to obtain absolutely pure substances, the photographs were minutely compared in order to separate the lines of the impurities. An impurity was considered absent when its longest and shortest lines were missing in the spectrum of the element under examination. Such careful comparisons required no less than 100,000 visual observations and the making of 2,000 photographs. The result proved that there was often a coincidence of short lines of the spectra of many metals, the purity of which was assured by the absence of the longest line.

Is it purely an accident that these short lines or "basic lines," as Lockyer has called them, coincide so strikingly? Or, are those bodies which we are accustomed to regard as elements very permanent combinations which are incompletely dissociated or split up at high temperature, and which in the form of short lines give the true spectrum of their constituents? In order to render such a dissociation more intelligible Lockyer conceives a series of furnaces, *A*, *B*, *C*, and *D*, in which the temperature decreases from *A* to *D*. *A* is supposed to ascertain a substance, *a*, which can combine with other bodies as the temperature falls, to form substances, *b*, *c*, *d*, of increasing complexity, contained in the furnaces, *B*, *C*, *D*, heated to a suitable temperature. It is evident that the spectrum of *a* is visible only in *A*, that of *b* only in *B*, etc.; but if a small quantity of a double compound, *c*, be brought into the furnace, *A*, we should at first obtain the three superimposed spectra of *a*, *b*, *c*, the spectrum of *c* being at first the brightest, followed in brilliancy by *b*. After a suffi-

cient time has elapsed only the spectrum of *a* will be seen. But since, in reality, the phenomena of dissociation are not so sharply defined, the strong lines of each spectrum will be represented by weak lines in the other spectra, especially if the temperature of the furnace, *a*, be lower than that of the complete dissociation of *b*. Unfortunately our means are still too limited to enable us to decompose an element in our laboratories. Lockyer has tried to solve the problem by studying the spectra of the stars. The spectrum of the brightest and hottest of stars, Bellatrix in the constellation of Orion is simple enough; besides a few hydrogen lines, there are only a few very fine lines which represent metals and which characterize elements of very small specific gravity, such as magnesium. The spectrum of the colder stars, on the other hand, such as the sun, or Deneb (α Cygni) show many more metals, but no metalloids; and the spectra of the coldest of

FIG. 8.—LOCKYER'S APPARATUS FOR THE SPECTROSCOPIC COMPARISON OF SOLAR AND TERRESTRIAL ELEMENTS.

stars, Betelgeuse (α Orionis), shows the characteristic band spectrum of metalloids and their compounds. In burning stars the temperatures of which vary from that of α Orionis to that of Bellatrix, the hydrogen lines are plainly visible; while the lines of the cleveite gases (helium and its associates) are not visible below the temperature of α Cygni. Sharply defined calcium lines are seen in the spectrum of stars having the temperature of Bellatrix. Iron lines are not obtained below the temperature of Cygni and are not visible at the temperature Bellatrix. The strong lines of magnesium are seen at the temperature of Cygni and are still slightly visible at the temperature of Bellatrix. Upon these facts Lockyer has based his hypothesis of cellestial dissociation according to which hypothesis the compounds in the different stellar types, with temperatures varying from those obtainable in our laboratories to those far greater than we can imagine, are first split up into their constituent elements, and these elements in turn dissociated into elements of smaller atomic weights, until everything is resolved into the universal primeval matter in the hottest sun. A few elements widely distributed in the universe are arranged by Lockyer in the order of their resistability to the effect of

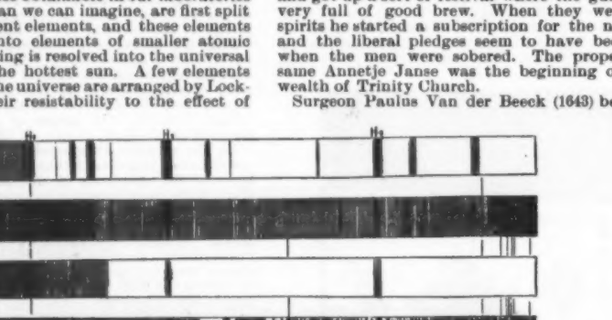


FIG. 9.—SPECTRA OF BURNING STARS.

rising temperature as follows: Gas X (the unknown member of the group of cleveite gases) helium, hydrogen, calcium, magnesium, iron. From the disappearance of the iron lines in the hottest stars and the simultaneous intensification of the hydrogen and helium lines and of the line representing gas X, the English astrophysicist concludes that iron is a compound which is formed in part by one of these gases.

The composite nature of the elements seems to be a well-founded theory, which investigators are justified in taking as the starting point of future researches. The first step has been taken in the attainment of new knowledge, when the dogma of impossibility has been set aside. We are not too sanguine in hoping that science will soon solve this old riddle of the nature of the elements.

THE dust from blast furnaces has been used on certain lands in France as a fertilizer and the results have been proved quite successful.

THE DOCTOR OUTSIDE OF MEDICINE.*

By WILLIAM L. STOWELL, M.D.

IN 1626, Peter Minuit bartered articles worth twenty-four dollars for Manhattan Island. It is now assessed for more than two billion dollars. Then there was no physician on the island; now there are three thousand dividing the medical honors and striving to divide the dollars. "Each man in his time plays many parts," and the parts played by our profession may well occupy us for a little time.

Perhaps the earliest genuine doctor to arrive was Peter Van der Linde, who came in 1638. When physic was slow he inspected tobacco, and gave part of his time to school teaching. He was also clerk of the church. He could not have all the obstetric work, because during his time Lysbert Dircksen was town midwife and lived in a house built at public expense. Her successor was voted one hundred guilders (thirty-eight dollars) annually to attend the poor.

About this time (1638–1647) there was in the council of Governor-General Kieft, Dr. John de la Montagne, "a man of intelligence and decision of character," a Protestant refugee from France, who had gone to Holland, and thence here. We find the colonists waging war against the Indians under "command of the indefatigable Montagne," and he later signs the peace treaty with them. There were at this time only a hundred white men on the island. One of them was Surgeon Hans Kierstede, from Saxony, who married Sara, daughter of Annetje Janse, "the famous midwife." This worthy pair had ten children, and so did what they could for the white population. More than that, Surgeon Kierstede was a director for the new church and got up a sort of festival where the guests became very full of good brew. When they were in good spirits he started a subscription for the new church, and the liberal pledges seem to have been all paid when the men were sobered. The property of this same Annetje Janse was the beginning of the great wealth of Trinity Church.

Surgeon Paulus Van der Beeck (1643) becomes rich by farming in Breuckeln, is tax collector and ferry master, and makes people wait for the boat "half a day and night."

Surgeon Jacob Varanger (1654) grows tired of being his own importer and consumer, so petitions the council to pay "for the use of his medicament," and to raise his salary as physician to the trading company. Varanga is claimed as one of the founders of the first hospital, yet his name is not in the list of twenty "great citizens," but among the two hundred and four "small citizens."

A little later on (1657) another composite doctor arrives—Samuel Megapolenisis, son of Reverand Megapolenisis. He is a Harvard graduate, who studied theology in Utrecht, and upon his return was appointed pastor of the church. He continued the rare art of both preaching and practising, and also did his part in politics, as appears from his being one of the commissioners at the English capitulation (1664).

In those days the palisade was along the present Wall Street. The only remaining relic of these early Dutch times is a portion of the foundation walls of 71 and 73 Pearl Street.

Those who died were buried just north of Bowling Green.

In 1666, Peter Harris, both physician and surgeon, was authorized to "exercise his art."

The term surgeon had been applied to ships' barbers, and had not the honor we now give it.

Gaudineau (1686), a Huguenot, also signs himself chirurgo-physician. He appears as lieutenant under Dongan in the French and Indian War (1708). There may be no significance in names, but it is curious to note that the first autopsy was held (1691) upon the body of Governor Slaughter, whose sudden death was thought to be due to poisoning. Dr. Johannes Kerfbyle, of Leyden, officiated.

The doctors did some fighting, not with Indians, as appears from the duel between Governor Dongan's nephew, Thomas, and Dr. John Livingston. The latter was killed and Dongan convicted of manslaughter.

In 1705, law and medicine combined in the person of Dr. Bridges, for a brief time chief justice.

In early days, slavery flourished here, and a slave market was established in 1709 at the foot of Wall Street. Dr. Dupay was a slave owner, for we find that he wants £55 for a negro wench nineteen years old whom he had brought up from infancy. She did not like being sold on approval, and a few years later is again offered for sale, "as she has a great itch for running away."

Quarantine was hastily established, in 1710, on Governor's Island, then Mutten Island. Three thousand German Lutherans had left Plymouth to come here to make tar, cut masts, etc. Four hundred and seventy of them were buried at sea. The council was dismayed when the large remainder arrived, and, "fearing distempers," appointed Dr. Garran, Dr. Law, and Dr. Moore to inspect the immigrants. Carpenters were also sent to build huts for them.

In 1725, Bedloe's Island was used as a quarantine for smallpox patients from Madeira.

About 1735, an almshouse, "publick workhouse and house of correction," was built in the fields or park. It was on the site of the present City Hall. Here slaves were kept for correction and the poor sheltered. Besides a salary, the keeper received fees from all who entered or were discharged, and 1s. 6d. for whipping. In 1764, the keeper was allowed £20 extra, as there had been no whipper for some time.

The second floor room on the Broadway side was the hospital ward, containing six beds. Dr. John Van Beuren was in charge on a salary of £100 a year.

It was here that Dr. Beekman Van Beuren introduced vaccination in the face of much opposition.

Dr. Gerardus Beekman, as president of the council, filled the executive chair in 1710 until the new governor arrived. He was a wealthy landowner, lieutenant-colonel of militia, etc. He was "the great gunner who shot a deer in city common, the antlers of which are still preserved in the family." He was one of the eight men condemned with Leisler when the latter was executed for treason in refusing to give up the fort. The doctor wrote to the governor that he wished to visit some patients on Long Island that were "very dangerous." Having leave to go, he neglected to come back to be executed.

Upon the arrival of Governor Clinton, in 1743, George Clarke returned to England said to be worth £100,000, "so profitable was it to rule New York." Ten years later Sir Danvers was governor. He had been deranged by grief at the loss of his wife, and two days after arriving here hanged himself from the fence in Mr. Murray's garden. Dr. Magraw, "the best physician in town," had ordered him sack and whey the day before, but he had refused it, telling the servant to prepare broth. Mr. Murray seemed to think this a sure evidence of madness. In 1743, Dr. McGrath introduced free cold bathing for the cure of fevers. He was an unrefined, captious man who was himself often "in hot water." These were troublous days in the colony. Smallpox and yellow fever prevailed (1737 and 1739), the Jews were disfranchised (1738), and thirty-four negroes and whites were executed for a plot to burn the city (1741).

About this time (1745) Dr. John Nichol died. He was an active practitioner and useful man, a member of the governor's council. In the same year Mr. John Dupuy, M.D., the man midwife, died, of whom the paper stated, "in which loss it may be truly said, as of Goliath's sword, 'there was none like unto him.'"

The most conspicuous physician of the last century was probably Cadwallader Colden (1688–1776). He was a Scotchman by birth. Wilson calls him "one of the ablest men in the province," and well he may. He graduated from the University of Edinburgh, studied medicine in London, and practiced the same in Philadelphia for several years. Governor Hunter induced him to come to New York and made him first surveyor general in the colonies. The governor suffered much from sciatica, and finally returned home. In a letter he says: "I have no hope of ease on this side, having try'd all remedys, Christian and Pagan, Polemical, Chymical, and Whimsical, to no purpose. Aix-la-Chapelle is all my present comfort." Colden's favorite study was botany, and he sent to Linnæus three or four hundred American plants. His pen was ever busy. He wrote on yellow fever a "History of the Five Indian Nations of Canada," and numerous scientific articles. He was for fifty years in his majesty's council, and for twelve years lieutenant-governor. On account of the stamp act in 1765 a procession of citizens burned in effigy Colden and the devil; however, at another time, fifty-six merchants congratulated him on his administration. At one time he had a country seat near Newburg, and again a large farm on Long Island. His intellectual capacity and attainments were great and various, one biographer saying that he was "known in the scientific and literary world as a physician, botanist, astronomer, and historian." He was the first to suggest the formation of the American Philosophical Society. He was loyal to the crown all his life, and died at the ripe age of eighty-eight years, in 1776, just after the English occupied New York.

The revolutionary period supplies medical anecdotes as well as war history. Dr. James Beekman erected a

* Read before the Society of the Alumni of the City (Charity) Hospital, February 8, 1899.—From the New York Medical Journal.

house in 1764 upon the bluff above East River at what is now Fifty-second Street. It stood there until 1874. This is a familiar spot to us of Charity Hospital. This historic house was at times occupied by such notables as General Howe, Sir Henry Clinton, and Madame de Riedesel. In the greenhouse there Nathan Hale was tried as a spy on September 21, 1776. He was then taken to City Hall Park and executed, not far from where his statue now stands.

The most important day this country ever saw was July 4, 1776, when the delegates from the thirteen colonies assembled in congress and declared American independence. All the fifty-six delegates present signed, and five of them were physicians. They were as follows:

Lyman Hall, from Georgia, a successful practitioner, afterward governor.

Benjamin Rush, graduate of Princeton when fifteen years old, who became professor of chemistry in the College of Philadelphia when twenty-four years old. He was surgeon-general of the hospitals during the war, and for the last fourteen years of his life treasurer of the United States Mint.

Oliver Woolcott, of Connecticut, was major-general in the army and held many high public offices, including that of governor. He and Hall were classmates in Yale in 1747.

Josiah Bartlett, of New Hampshire, was a "noble patriot"; for ten years in legislature and congress, governor of his State, justice of the supreme court, and first president of the State Medical Society.

The last signer was Dr. Mathew Thornton, from Londonderry, New Hampshire. He was a practitioner and "most ardent patriot," whose monument bears the simple inscription, "An honest man."

New York sent few doctors to the war, but among these zealous patriots are mentioned James Brewer, Moses Younglove, Ebenezer White, and Daniel Menema. She had seventeen original members in the Society of Cincinnati.

In 1790, congress removed from City Hall, New York, to Philadelphia. On October 14 of that year the medical society was allowed to use the council chamber for its meeting. There Dr. Nicholas Romaine gave medical lectures a year or two later.

At that time the medical society numbered twenty-eight members. Among the noteworthy men were Dr. John Bard and his son, Dr. Samuel Bard, who operated upon the carbuncle that afflicted George Washington.

Dr. John Bard (1716–1799) was a very eminent man, noted for his urbanity of manner as well as great learning. He established the first quarantine at Bedloe's Island, and was first president of the New York Medical Society organized in 1788. He was usually dressed in a red coat and cocked hat and carried a gold-headed cane. He drove in a low phaeton and was accompanied by a colored servant.

Samuel Bard (1742–1821), son of John, graduated at Columbia, and took his M.D. in Edinburgh. He organized the first medical school with Columbia, then King's College, and in 1769 took the chair of physic. He was dean of the faculty.

Dr. John Cochrane was evidently a man of wealth, as he lived on Broadway and entertained the generals of the army in a royal manner (Lamb).

No one enjoyed a higher social position and influence at this time than Mrs. John Jay. On one date, her only guests at dinner were Dr. and Mrs. John Charlton. Charlton was an English surgeon from the court of George III., who came with the army. He married Mary de Peyster. He usually rode on horseback, but practiced little. In 1795, yellow fever again raged. The cabin boy and surgeon of a West Indian ship were the first to die. The disease spread, only to be checked by the frosts of November. Governor Jay then set Thursday, November 26, as Thanksgiving Day, as had previously been done in Massachusetts. More than fifteen hundred persons had died of the population of fifty thousand. This scourge resulted in underground sewers being begun. At this time there were one hundred students in Columbia and fifty more studying medicine.

Prof. McMaster, writing on yellow fever, gives this interesting picture: "If the purchaser of the vinegar (for prevention) were a nervous man and tormented with hourly fear of being stricken with the fever, the spectacle he presented as he sallied forth to buy was most pitiable. As he shut his house door he was careful to have a piece of tarred rope in either hand, a sponge wet with camphor at the nose, and in his pocket a handkerchief well soaked in the last preventive of which he had heard. . . . If he were so unhappy as to meet a friend on the way, neither shook hands, but exchanging a few words at a distance, each sought, bowing and scraping, to get to the windward of the other as he passed. When at last the shop was reached, nothing could induce him to enter while another stood at the counter, or was seen approaching on the street" (Wilson).

April 13, 1788, was the date of the "Doctors' Riot." This was caused by some inquisitive boys discovering the hospital doctors dissecting. They spread ghastly tales and soon had an angry mob after the young medics. The doctors sought safety in the jail, but barely escaped being removed from there. Dr. Hicks was hiding behind the chimney of his preceptor's house (Dr. Cochrane) while the mob were below, looking for him and evidences of his dissecting. The trouble lasted part of two or three days and was only quelled by the militia. Baron Steuben and Secretary Jay were endeavoring to quiet the mob by speeches when both were injured by flying missiles. Steuben was just praying that the soldiers should not be allowed to shoot when he was hit upon the head with a brick. As he fell he cried out, "Fire, Governor, Fire!" and it was done.

Nicholas Romayne was a native New Yorker, 1765–1817. His weight of three hundred pounds did not affect his activity. He was "vested with almost all the honors the medical profession can bestow." He could upon invitation "lecture on the aphorisms of Hippocrates, unfold the structure of the brain, expound the philosophy of paludal diseases, or discourse on the plant which Clausius cherished." He was "at all times assiduous in civic pursuits and closet studies," a type of what a physician should be to a community.

Dr. Hugh Williamson (1735-1819) was another man of many gifts. He was ordained to preach, but gave up because of his health. He studied medicine in Edinburgh and Utrecht and practiced successfully in Philadelphia. He was surgeon in the army, member of the North Carolina House of Commons, delegate to the convention to frame the Constitution, and was elected as a federalist to the first congress.

In Philadelphia he was professor of mathematics and one of a commission to observe the transit of Venus and Mercury.

Seventeen hundred and ninety-eight was marked by the invention of the steamboat. In March of that year Dr. Samuel L. Mitchell, then a representative in the legislature, introduced an act granting the exclusive right to navigate the New York waters by fire or steam for twenty years. The bill was passed very much as a joke. In April, 1807, Fulton actually made the trip from New York to Albany in the "Clermont" at the rate of five miles an hour. Dr. Mitchell was one of the passengers, and, as Colden was backing the scheme, he was probably there also.

The most remarkable man of his time was Samuel Latham Mitchell, M.D., LL.D. (1764–1831). He graduated in medicine in Edinburgh, and returning here studied law with Chief Justice Yates.

For twenty years he was visiting physician to New York Hospital. As a teacher, he was professor of chemistry and natural history in Columbia, professor of botany and materia medica in the College of Physicians and Surgeons, and one of the faculty of the Rutgers Medical School. His analysis of the Saratoga mineral waters helped their fame.

In 1796, he made a geological and mineralogical tour of the State, the published results of which laid the basis of his European reputation.

In 1797, together with Dr. Edward Miller and Dr. Elisha H. Smith, he founded (and for sixteen years edited) The Medical Repository, the first medical journal in this country.

His knowledge of the Indians was thorough. When they gave exhibitions at the Elgin Gardens he would translate their war songs; and because of his legal knowledge he was sent to make a treaty with them.

In politics he was in the State legislature working hard with Cadwallader Colden and Governor De Witt Clinton for the Erie Canal. In 1825 it was opened with the greatest naval fête the city had ever witnessed. Dr. Mitchell had procured bottles of water from the thirteen largest rivers in the world—Ganges, Nile, Mississippi, Amazon, etc.—and united them all in this artificial waterway. The doctor counted it the proudest day of his life when the inland lakes and ocean were united in "indissoluble marriage." It cost $7,602,000 then. We heard more about its cost last autumn. With Williams we find him working for the furtherance of West Point Military Academy. As United States senator he puts his energies into improved quarantine laws. With the ever-active Colden and others he established the Deaf and Dumb Institute. When State aid was wanted for the Botanical Gardens at Fiftieth Street, he talked for hours to the legislature, and that without special preparation. Naturally, he was among the incorporators of the Society for the Establishment of Free Schools in 1805.

Socially he was a delightful companion, not an abstract philosopher. He was Sachem of Tammany Society, was an active member of nearly all the learned societies of the world, and yet found time to preside over the "Krout Club," or discuss conchology with Dr. Samuel Akerly, his brother-in-law.

His writings include "Theory of the Earth and Solar System Phosphorescence of the Ocean," "Anatomy and Physiology of the Shark," a description of the fishes about New York (one hundred and sixty-six varieties), and "The Ethnology of the Indian."

It is little wonder that Dr. Francis called him "the Nestor of American science."

In St. Paul's churchyard at Vesey Street, on the Broadway side, there stands near the fence a large monument which you have probably all seen, but perhaps not stopped to observe. It is that of the Irish patriot who made this his adopted home. Dr. William James Macnevin (1763–1841) was educated in Vienna, practiced in Dublin, traveled in and wrote of Switzerland, and spent four years in an Irish jail. "He had no prison house; worth, freedom, Wisdom still can walk at large, though bolts and bars, and walls of adamant may intervene." He translated from the original Gaelic, and compiled a French grammar for the children of Thomas Addis Emmet, his fellow prisoner.

On July 4, 1804, he landed here, and at once began practice. He gave clinics in the almshouse (1807), and was professor of midwifery in the College of Physicians and Surgeons, and professor of materia medica in Rutgers Medical School. He was also professor of chemistry. Dr. Francis says that "the stores of ancient and modern science were equally accessible to him, and he was ever ready to communicate." When he died, "all felt that learning had lost a distinguished ornament, . . . the charities of life an ardent friend, and patriotism one who had sustained martyrdom in her glorious cause."

Another man in the faculty with Dr. Mott, Dr. Macnevin, and Dr. Francis, was Dr. David Hosack, "distinguished beyond all his competitors in the healing art" (1769–1835). Beginning with materia medica, he became professor in all the branches except anatomy and surgery. In 1804, he had to do with a tragedy which a part of our history. When Alexander Hamilton was shot by Vice-President Burr on that early July morning at the Weehawken dueling ground, Hosack was waiting for him in a boat below the cliff. This was the untimely end of the great Hamilton, and the end of dueling in this country.

Dr. Hosack's favorite study was botany, and in 1801 he succeeded in establishing the State Botanical Garden upon twenty acres bounded by Forty-seventh and Fifty-first Streets, between Fifth and Sixth Avenues. This was for the "conservation of our indigenous botany, or as a repository of the most precious exotics." It was a curious and valuable place in many ways, but not very useful, so the property was turned over to Columbia College. You all know how valuable the ground has proved to it. Dr. Hosack was one of the originators of the New York Historical Society, and twelve years its president.

In 1824, when Lafayette revisited America after half a century of absence, he was shown all possible honors, and Dr. Hosack, conducting him to the chair that once belonged to Louis XVI., "in a graceful speech tendered him his election as an honorary member of the Historical Society."

His name is connected with most wise and great affairs of his day. It was he who established the library of New York Hospital, which has now been (1898) transferred to the Academy of Medicine.

"It was not infrequently remarked that Clinton, Hosack, and Hobart were a tripod on which our city stood."

Another botanical M.D. was James E. De Kay (1792–1851), an all-round naturalist. His travels took him to Turkey, where he became superintendent of the naval yards. He returned to Oyster Bay, near his intimate friend, the poet Bryant. Though he cared little for practice, he came here at once to help care for the cholera patients, and wrote chiefly for the New York press.

John W. Draper, M.D. (1811–1882), chemist and physiologist, was a many-sided man. After practising a few years in Virginia he came here, and with Mott and others founded the New York University Medical College. He did much in the early days for photography. It was he who first photographed from high-power microscope lenses. He wrote with equal ease upon chemistry, "Intellectual Development of Europe," "The Future Policy of America," and the "Conflict between Religion and Science."

Contemporaneous with Dr. Draper, though older, was another M.D. who did not practice—Peter Irving (1771–1838), M.D., from Columbia. Peter was brother of Washington Irving, and helped the latter with the immortal "Knickerbocker's History of New York." He found the pen mightier than the bistoury, and after traveling widely abroad led a literary life, being noted for his "classical acquisition and belles-letters knowledge."

Medicine combined with art in the anatomical lectures given by Dr. T. G. King before the National Academy of Design. The academy originated with S. F. B. Morse, of telegraphic fame, who was its president for many years. He was a great painter, especially of portraits. One of Lafayette by him is still in the City Hall. Morse and King continued the anatomical lectures many years.

In January, 1831, chemists, physicians, and others began to agitate the subject of pure water. Dr. De Kay prepared a report including a quotation from Devoe in 1798, to wit: "The collect behind the tea-water pump is a shocking hole, where all impure things center together and engender the worst of unwholesome productions." All this is now completely changed; the shocking hole has been filled up, and in or on its place stands the Criminal Court Building, where the New York Health Department resides and engenders hygienic laws and antitoxines instead of "unwholesome productions." The Croton water supply was brought to the city with a great celebration in 1842, having cost twelve million dollars.

In the medical history of New York no one took so great an interest as John W. Francis, M.D., LL.D. (1789–1861). In 1809, Dr. Francis was the first man to receive the degree of M.D. from the College of Physicians and Surgeons. He later was professor of materia medica, of medical jurisprudence, and of obstetrics there. He was greatly interested in all the hospitals, asylums, and benevolent institutions of his time. He said "you might as well create a practical navigator by residence in a sylvan retreat as furnish a physician without hospital experience."

Dr. Francis was the medical friend of the leading actors from Cooke to Macready. Kean went with him to Vauxhall Garden (where Astor Library now is) and turned somersaults there. They then went to Bloomingdale, as Kean was anxious to see if our insane were like those in England. He nearly ended his own life on this trip. Dr. Francis wrote various medical papers, but is now best remembered by his "Old New York, or Reminiscences of Sixty Years." Though a busy practitioner, he had time for the meetings of the famous "Bread and Cheese Club," where he met the naturalist, Dr. De Kay, and Charles King, later president of Columbia.

Dr. Kane, the Arctic explorer, was born in Philadelphia in 1820, and entered the navy as surgeon. He was a great traveler, and visited all parts of the world while on duty or during furloughs. During the Mexican War (1846) he was with the military staff. Being a naturalist as well as a sailor, he went with the first Grinnell Expedition from here in 1850. In 1853, he commanded the "Advance," and first definitely determined the existence of an open polar sea. His expedition accomplished more than any preceding one, and brought him honor and fame. His health failed, and he sought relief in Havana, where he died in February, 1857.

Another man to whom we New Yorkers are especially indebted is Rufus H. Gilbert, M.D. (1832–1885), who invented the elevated railroad. He was a student of Willard Parker, and graduate of the College of Physicians and Surgeons. In 1862, he was surgeon to the Duryea Zouaves, and performed the first surgical operation under fire at Big Bethel. Later he was director of the army hospitals. After the war his health failed, and he became assistant superintendent of the Jersey Central Railroad. He was greatly interested in the overcrowding of the poor districts, and so labored to find a way of relief. The original elevated railroad, from Battery Place through Greenwich Street to Thirteenth Street, was begun in 1867. Dr. Gilbert at first held a large amount of the stock, but he lost most of it, and his death was really hastened by anxiety and disappointment.

In these days of interchanging war and peace we are reminded of Richard J. Gatling, M.D. (1818), who is still living in our city. His inventions so filled his mind that he never practised medicine. When a boy he perfected a cotton-seed sower and a wheat drill. (How he might have helped the gynæcologists with cases of sterility!) In 1861, he invented the revolving gun which was tried by General Butler and later adopted by the United States service. It is, as you know, virtually ten breech-loading rifle barrels together, and can now deliver twelve hundred shots a minute. Its efficiency may be learned by reference to the Manila battles of recent dates.

Of all medical men and patriots there is none whose history is so romantic or whose deeds are so daring and magnificent as those of Marcus Whitman. His name is inseparable from that rich territory

"Where rolls the Oregon, and hears no sound
Save his own dashings."

In 1836, he left this State with his young wife for a

bridal tour of thirty-five hundred miles. When the party reached Fort Laramie the garrison tried to prevent his going beyond with his old "wagon." The great forests were then occupied only by Indians and traders of United States origin or belonging to the Hudson Bay Company. There this little band meant to go and did go. In 1842, six years later, Whitman was visiting a patient at Walla Walla and attended a dinner of traders and others where an express rider announced that a quantity of immigrants were two hundred and three hundred miles above, coming down there. An enthusiastic priest jumped up, shouting shouting, "Hurrah for Oregon! America is too late!" Whitman grasped the situation, and left for home. In twenty-four hours he had started, in spite of all entreaties not to do so, to ride to Washington to see Webster before the Ashburton treaty should be signed, and Oregon lost to the United States. It was a rich possession, of thirty-two times the size of Massachusetts, and Whitman's residence there six years showed him its value. The experiences of four months of winter spent in the saddle, pushing on constantly over mountain passes, through forests, swimming rivers frozen half over, at times eating dog meat and mule meat, and once being wholly lost—what history it is, and what an indomitable will the man had! Mr. Lovejoy and the guides were his companions, yet he may be said to have made the trip alone.

After five months' travel he reached Webster at Washington, and set aside all the arguments against the worthless and inaccessable land. When told that wagons never could be taken over the mountains, his sufficient reply was, "My wagon is there now." He returned on September 4, 1843, with two hundred wagons and nearly a thousand persons (eight hundred and seventy-five) and thirteen hundred head of cattle.

Daniel Webster said, "It is safe to assert that our country owes it to Dr. Whitman and his associate missionaries that all the territory west of the Rocky Mountains and south as far as the Columbia River is not now owned by England." The rides of Paul Revere and Sheridan were momentous, but Whitman outdistanced them and saved us six thousand miles of Pacific coast and inestimable wealth yet to be secured. Poor Whitman and his family were massacred in November, 1847. Compare his journey with a trip by the Northern Pacific or Sunset Limited. Since his day our western horizon has been pushed seventy-five hundred miles farther.

I cannot well refrain from reference to one eminent doctor now living and very active—Dr. Leonard Wood, now brigadier-general and military governor of Santiago. Governor Roosevelt, his long-time friend, counts him one of our most superior public men. He received his medical diploma from Harvard in 1882, and for a short time practiced in Boston. His adventurous spirit led him into the army, and shortly we find him with General Miles fighting the Apaches. His great power of endurance, his kindly manner, and unusually sound judgment soon made him the natural leader of some of the detachments sent out. He soon won the medal of honor. It was the most natural thing in the world that he should command that unique regiment, the Rough Riders, and his evident executive ability and justice made him the natural selection as governor of the province. He is a man whom we may proudly claim as one of us, though he has grown out of medicine.

There is one doctor who belonged to all English-speaking people—Oliver Wendell Holmes, M.D., LL.D. (1809–1894), tthe "autocrat," "professor," and "poet." A sudent of law, then of medicine; professor of anatomy and physiology for forty-four years in Dartmouth and Harvard; a poet from his college days to the end of his long life. The dry subject of anatomy he enlivened by comparing the sweat glands to a fairy's intestine, and the mesentery to shirt ruffles of a former generation. He wrote "Lectures on Homœopathy and Kindred Delusions," and many other medical topics, yet found time to write fourteen volumes not medical.

Dr. Holmes was pre-eminently the poet for occasions

> "When the tongue has grown loose
> And the waistband grown tight."

He frequently came to New York (where else can a Boston man go?), in 1853, to attend the meeting of the American Medical Association, and later the semi-centennial of the New England Society. When the new Fifth Avenue Theater was opened, "they were something more perplexed for poets than for port and sherry," and Dr. Holmes was the poet guest. His most notable visit here was in 1883, when the New York medical profession honored itself in honoring him with a dinner at Delmonico's. Two hundred and fifty most eminent physicians and guests united in paying tribute to the genius, wit, and learning of the doctor-poet, who could

> ". . . show with demonstrator's art
> The complex chambers of the heart,
> Or, armed with diviner skill,
> To made it pulsate at his will."

Among the speakers were Dr. Barker, Dr. A. H. Smith, and Dr. T. G. Thomas, the Hon. William M. Evarts, George William Curtis, Whitelaw Reid, and, best of all, the doctor himself in a poem.

This paper must have an end, and perhaps it had better be here. We have found that the knowledge of medicine adds to the efficiency of those possessing it; that it is compatible with many things else—law, preaching, literature, painting, poetry, natural history, exploration, astronomy, invention both in the arts of war and peace, and adds dignity, honor, and usefulness to a man in any profession.

Tooth Powders.—The Zahntechnische Reform publishes the following recipes:

I. Menthol, 1 gramme; betanapthol, 0·5 grammes; saccharine, 0·25 gramme; lime carbonate, 500 grammes;

II. Myrrh, 10 gramme; sodium chloride, 10 grammes; soot, 5 grammes; soap, 5 grammes; lime carbonate, 500 grammes.

III. Camphor, 5 grammes; soap, 10 grammes; saccharine, 0·25 gramme; thymol, 0·5 gramme; lime carbonate 500 grammes. Scent, as desired, with rose oil, sassafras oil, wintergreen oil, or peppermint oil.

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